Thank you for your comment, Anne Alexander.

The comment tracking number that has been assigned to your comment is SolarD11901.

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Solar Energy Development PEIS
Comment ID: SolarD11901

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Attachment: BNSF Comments to Draft Solar PEIS Part 1.pdf

Comment Submitted:

Name
Title

BNSF Railway Company
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May 2, 2011

Solar Energy Draft PEIS
Argonne National Laboratory
9700 S. Cass Avenue – EVS/240
Argonne, Illinois 60439

Re: Comments on Draft PEIS

The following comments are submitted on behalf of BNSF Railway Company ("BNSF"). BNSF appreciates the opportunity to comment on the Draft PEIS.

1. Overview

BNSF is one of two Class 1 railroads operating in the Southwestern United States. BNSF appreciates the opportunity, as a part of the Bureau of Land Management ("BLM") and Department of Energy's ("DOE)" review process relating to the Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States (the Draft "PEIS"), to provide comments to develop an agency-specific program to facilitate responsible utility-scale solar energy development in western states.

BNSF provides long-haul freight service throughout the U.S. over a 32,000-mile route. Its double-track transcontinental mainline, traversed by as many as 80 trains per day, carries interstate commerce from the Ports of Los Angeles and Long Beach to U.S. Midwestern, Southwestern and Eastern markets. The BNSF mainline is adjacent to BLM lands in California, Arizona and New Mexico which are proposed to be made available for application for solar development under the Preferred Solar Energy Development Program Alternative ("Preferred Alternative") evaluated in the Draft PEIS. In addition, the BNSF mainline is situated within or in close proximity to a number of Solar Energy Zones ("SEZ") being evaluated in the SEZ Alternative of the Draft PEIS. [1]

BNSF disagrees with the summary conclusion that "utility scale solar energy projects are expected to have an insignificant impact on railroad operations." [PEIS at 5-253.] In addition to

[1] The BNSF mainline runs directly through the center of the Pisgah SEZ. [PEIS at 9.3-1.] The BNSF mainline connects to the ARZC railroad through an interchange with the ARZC railroad, which is within the Iron Mountain SEZ [PEIS at 9.2-299] and Riverside East SEZ [PEIS at 9.4-365]. The BNSF mainline (as well as the Union Pacific mainline) run within 1-5 miles of the border of the Afton SEZ. [PEIS at 12.1-1; Figure 12.1.1.1-1.]

an "increased risk of collision between a train and a vehicle ... most notably from drivers trying to beat a train because of frustration with site-related traffic congestion," [PEIS at 5-254.] there are other significant impacts to rail operations which have been testified to in the siting of a utility-scale solar energy project, the Calico Solar Project, in San Bernardino, California.

These impacts include glare and glint impacts from solar technology which would have adverse impacts, including health impacts, on rail employees, agents or contractors, and operations, including a train crew's ability to accurately see and respond to signals. Associated glint and glare from solar technologies could interfere with the ability of train crews to obtain and maintain this visual contact. If visual contact is broken, under GCOR Section 9.4 the engineer must immediately stop the train. This often requires an emergency application of the brakes, risking derailment of the train, collision with another train, and other catastrophic events. When a train has been stopped through emergency application of the brakes, GCOR Section 6.23 requires the engineer to inspect all cars, units, equipment and track pursuant to BNSF special instructions and rules. This can cause significant delays to rail operations with ramifications reaching from the Ports of Los Angeles and Long Beach to Chicago and beyond. Thus, glint and glare are critical safety and operational issues. We attach as ***Exhibit A*** the prepared direct testimony of Joseph Schnell, a BNSF employee, ***Exhibit B*** the prepared direct testimony of Dennis Skeels, a BNSF employee, and ***Exhibit C*** the prepared direct testimony of Dr. David Krauss and Dr. Genevieve Heckman, experts in the field of neuroscience, all of whom provided testimony regarding the Calico Solar facility's potential impact on BNSF rail operations from glare and glint. Dr. Krauss identified the need for a site-specific glare and glint study to identify site-specific mitigation measures on the footprint of the solar project. Given the discussion in Chapter 5 with respect to the reflective surfaces of all solar technology, absent the site-specific modeling described below, BNSF requests BLM and DOE require a buffer zone of two miles on both sides of all rail lines and explicitly provide that no exception to the buffer be granted without the modeling having confirmed that no adverse impacts, including health impacts, to rail employees, operations, and right of way would result, and that any mitigation measures be imposed on the footprint of the proposed project.

In addition to the glare and glint impacts from the solar technology, placement of a transmission line in the vicinity of a rail line may result in interference with signals, equipment malfunction, and rail employees being shocked, even fatally. See ***Exhibit A*** and ***Exhibit B***, prepared direct testimony of Joseph Schnell and Dennis Skeels in the Calico Solar proceeding. Mitigation measures for adverse induction impacts include requiring transmission lines to be set back 300 feet from the edge of the railroad right-of-way and requiring any crossing of the transmission line over the rail line to be at a 90-degree angle. These impacts should be discussed in at least sections 5.13.1.5 on page 5-208 and 5.19.1.1 Transportation Siting on page 5-253.

The impacts from stormwater runoff and sediment transport can have significant adverse impacts on nearby rail rights-of-way. BNSF concurs with the discussion in the PEIS on pages 5-19 through 5-26 regarding utility-scale solar projects' potential impacts on the Geologic Setting and Soil Resources. We attach as ***Exhibits D*** and ***E***, respectively, the prepared direct testimony of Thomas Schmidt and David Miller, BNSF employees, and as ***Exhibits F*** and ***G***, respectively, the prepared direct testimony of Steve Metro and Doug Hamilton, experts in the field of hydrology, all of whom testified to the significant stormwater runoff and sediment transport impacts onto, across and off the Calico Solar Project onto the BNSF right-of-way absent the installation of proper mitigation measures. It is imperative that the proper studies be performed to evaluate potential adverse impacts and to identify appropriate project elements or mitigation measures to address those impacts. In some instances geologic factors should be used to exclude portions of BLM and private lands from solar development. In all cases, these site-specific studies need to be prepared early enough in the application process to inform responsible and commenting agencies, stakeholders and interested parties prior to the performance of environmental reviews and the submission of comments.

BNSF concurs with the PEIS's conclusions in 5.7.1.4 regarding the range of impacts involved in the decommissioning/reclamation of a utility-scale solar facility and requests BLM and DOE to require a thorough analysis of each of the elements of decommissioning and reclamation and their associated costs. Once the true cost is established, BLM and DOE should create a financial mechanism by which the availability of decommissioning/reclamation funds can be ensured throughout the life of the project. Otherwise, adjacent landowners such as the railroad may be severely adversely impacted by ill-maintained or abandoned utility-scaled facilities the size of small cities.

Water usage and depletion of groundwater by solar facilities can result in the undermining of rail infrastructure. The effects of subsidence can cause a need for increased maintenance and increase derailments. See ***Exhibit D***, prepared direct testimony of Thomas Schmidt in the Calico Solar proceeding.

A major area of concern for the railroads, as will be more fully discussed below, is ensuring that the project proponent provide access to all portions of its facility using existing public crossings of any nearby rail lines. There is an ongoing effort by railroads, in conformance with federal and state policies, to eliminate private crossings thereby reducing their related hazards and risks. The PEIS and subsequent site-specific environmental analyses should incorporate this requirement into their analysis of transportation impacts.

Given the critical importance of rail infrastructure to the movement of goods, emergency access to all rail right-of-way needs to be preserved in the granting of any right-of-way for a solar development project. We attach as ***Exhibit H*** the prepared direct testimony of Edward Phillips, a BNSF employee, who testified to the need for emergency access to the rail line in the Calico Solar proceeding.

Clearly there are further analyses that need to be performed, with respect to the impact of utility-scale solar energy facilities, on rail operations than have currently been performed in the PEIS. We request BLM and DOE to address these concerns prior to the preparation of the FEIS.

2. Comments on Cooperating Agencies

The PEIS identifies a list of cooperating agencies for the preparation of the PEIS. [PEIS at1-19-20.] BNSF requests that BLM and DOE also consult with the Federal Railroad Administration (FRA) as to those aspects of the proposed actions and alternatives which could impact rail employees and operations under the Preferred Alternative or SEZ Alternative. In addition, BNSF requests the list of laws, ordinances, regulations and standards (LORS) applicable to the proposed Solar Development Program Alternative and SEZ Alternative set forth in Appendix H be augmented with a Table H-16 to include applicable LORS relating to rail, including the Supremacy Clause, U.S.C.A. Const. Art. VI, cl. 2, the Commerce Clause, U.S.C.A. Const. Art. 1, §8, cl. 2, the Federal Railroad Safety Act of 1970, 49 U.S.C. §§20101-20144; 21301-21304 ("FRSA"); the Rail Safety Improvement Act of 2008, Public Law 110-432 ("RSIA"); the Interstate Commerce Commission Termination Act of 1995, 49 U.S.C. §§10101, et seq. ("ICCTA"), and the BNSF General Code of Operating Rules ("GCOR"), BNSF's federally-regulated operating procedures. [2]

3. Comments on BLM Planning Criteria

BNSF requests BLM to add the coordination with rail lines "in the PEIS and plan amendment process to strive for consistency with existing plans and policies..." [PEIS at 1-15, seventh bullet point.] BNSF also requests BLM add a planning criteria to address the needs of transportation infrastructure and operations, such as highways and railroad rights-of-way, adjacent to or within the areas affected by the Preferred Alternative or SEZ Alternative. [PEIS at 1-15.] More specifically, we request a criterion that "the BLM will protect pre-FLPMA rights-of-way, including rail rights-of-way, from the impacts of solar projects."

4. Further Comments on Project Impacts

Given the critical importance of this transcontinental rail corridor, it is essential that safety along BNSF's mainline be maintained. Accordingly, BNSF has significant concerns that the construction and operation of any solar energy project not adversely impact BNSF operations or otherwise impose unacceptable safety risks to BNSF personnel and operations. While BNSF appreciates that "site-specific and species-specific issues [will] be addressed during individual project reviews," there are several issues that can and should be identified on a programmatic level. [PEIS at ES-5.] BNSF's comments are focused on the Draft PEIS objective of "identif[ying] relevant design features (i.e., mitigation requirements) applicable to solar energy development in general." [PEIS at ES-5.]

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[2] Railroads are required to file their operating rules and any amendments thereto with the FRA. The operating rules are intended to ensure safety in railroad operations (GCOR Section 1.1), and railroads are required to periodically monitor compliance with their operating rules. 49 C.F.R. 217.9. Railroads must periodically instruct their employees on the meaning and application of the operating rules (49 C.F.R. Part 217.11), and must have a program to monitor the conduct of their certified locomotive engineers and their compliance with "provisions of the railroad's operating rules that require response to signals that display less than a 'clear' aspect..." 49 C.F.R. Part 240.303(d)(1)(i). A railroad is required to revoke the certificate of an engineer who fails to meet the qualification requirements of Part 240, which may be established by an engineer's failure to control a train in accordance with a signal. 49 C.F.R. Part 240.307. A railroad's failure to comply with the provisions of these regulations may subject the railroad to civil penalties.

BNSF operates in 28 states in the midwestern and western United States and Canada. It is the product of hundreds of predecessor companies that were merged or acquired over the past 150 years to form a unified interstate system. It is the second largest railroad in North America, and has a large freight rail presence in California, Arizona, and New Mexico. Railroads provide the most efficient, environmentally protective, and safest form of overland freight transportation in the United States, and it is the policy of the Federal Government to promote freight rail transportation.

As noted in the PEIS, "the BLM currently evaluates solar energy ROW [right-of-way] applications on a project-specific basis, a process that involves assessment in accordance with the requirements of NEPA, Title V of the Federal Land Policy Management Act of 1976 (FLPMA), the Endangered Species Act (ESA), the National Historic Preservation Act (NHPA), and other applicable statutes and regulations." As of February 2010, BLM was in the process of reviewing 127 applications for FLPMA ROW authorizations for solar facilities to be located on BLM-administered lands. [PEIS at ES-1.] While recognizing the potential benefits of a programmatic approach to the evaluation of the impacts of solar energy projects, it is BNSF's position that the Preferred Alternative is overly broad with respect to the BLM lands which it would make available for application for solar energy development. The approach taken in the SEZ Alternative is preferable in that it strictly limits the areas for solar energy project development to those areas identified by BLM as best-suited for large scale power generation. Nonetheless, it is BNSF's position that the SEZ Alternative is also overly broad. In this early stage of the development of solar energy, it is possible that many impacts of such projects are as yet unstudied or unknown. Adoption of the Preferred Alternative would lessen the requirements for environmental review for nearly 22 million acres of BLM lands. As such, it could result in the approval of solar projects in areas where such development would result in adverse impacts, including health impacts, from glare and glint on BNSF's employees, agents or contractors and operations, including a train crew's ability to accurately see and respond to signals.. The SEZ Alternative is more conservative, facilitating development of utility scale solar energy projects on 677,400 acres of BLM managed lands. However, the SEZs have been established directly adjacent to BNSF and other rail lines throughout much of the six-state area, and BNSF is concerned that the development of such projects adjacent to its rail lines would result in significant adverse impacts, including health impacts, to BNSF's employees and contractors, and critical rail operations. As discussed, BNSF requests BLM and DOE exclude from the Preferred Alternative and the SEZ Alternative all lands, public or private, within two miles of a rail right-of-way in their siting of utility-scale solar facilities.

BNSF's mainline is within BNSF's right-of-way ("ROW"), which is a pre-FLPMA right-of-way. A right-of-way issued by the Secretary of the Interior under FLPMA must contain terms and conditions that "protect Federal . . . economic interests . . . [and] protect the other lawful users of the lands adjacent to or traversed by such a right-of-way." [43 U.S.C. §1765(b).] A right-of-way granted pursuant to FLPMA must be compatible with an adjacent pre-FLPMA right-of-way. FLPMA does not grant the Secretary of the Interior the right to terminate, restrict, or impede the rights of the holder of a pre-FLPMA right-of-way. [43 U.S.C. §1769.]

As a major transcontinental transportation corridor responsible for the shipment of a significant portion of the goods to and from the west coast, the federal government has an important economic interest in ensuring that rail traffic is not interrupted. FPLMA makes it clear that it does not grant the Secretary the right to terminate a right-of-way that was issued before the FLPMA – such as the BNSF ROW. 43 U.S.C. §1769(a). Nor can the Federal government take any action to restrict or impede the rights of a holder of a pre-FLPMA right-of-way.[3] *See, e.g., City and County of Denver, by and Through Bd. Of Water Comm'rs v. Bergland*, 695 F.2d 465 10th Cir. 1082) (US Forest Service cannot impede City's planned water project inasmuch as it is an authorized use of a pre-FLPMA right-of-way through national forest lands).

A. Hydrology

The Draft PEIS notes that BLM "Staff was asked to identify areas that were near existing transmission or designated corridors, near existing roads, generally had a slope of 1 to 2% or less, and were a minimum of 2,500 acres ($10.1km^2$)." [PEIS at ES-7.] Because BNSF's mainline traverses and its ROW is within or immediately adjacent to utility corridors and transmission lines, BLM Staff has been asked to identify potential SEZ's that are in close proximity to BNSF's mainline and ROW. BNSF's mainline has, in many areas, been in place for over a hundred years. The BNSF mainline has countless bridges, trestles, culverts and other features designed to protect it from normal and sudden hydrologic runoff over and within the topography within which BNSF's mainline is situated. While the Draft PEIS asks BLM Staff to identify potential SEZ's with a slope of 1 – 2% or less, there are a number of proposed SEZ's that have slopes in excess of 1 – 2%.[4]

A natural consequence of any solar development project is a change, both temporarily during construction and permanently throughout the life of the project, to the respective hydrology associated with the project site. Accordingly, it is critical that appropriate, site-specific hydrological studies[5] be conducted well in advance of the emplacement of the respective technology. BNSF's experience with the Calico Solar Project has made it abundantly clear that these studies will establish the locations of any hydrological features – such as but not limited to

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[3] FLPMA and NEPA require that lands adjacent to the proposed Project right-of-way be protected. Such protection cannot be accomplished without "full and fair discussion of significant environmental impacts" (40 C.F.R. 1502.1) and a discussion of the "means to mitigate adverse environmental impacts" (*Id.*) as required by NEPA, 42 U.S.C. 4321 *et seq.*).

[4] For example, the Draft PEIS refers to "[s]ix fast-track projects" in California, to include the Calico Solar Project. The Calico Solar Project is within the proposed Pisgah SEZ. The Calico Solar Project has a slope that ranges from 3 - 6%. [See Staff Assessment and Draft Environmental Impact Statement, Calico Solar Project, (08-AFC-13), dated March 30, 2010, at B.2-52.]

[5] Typical hydrology studies include a Drainage Erosion and Sedimentation Control Plan ("DESCP"), a Storm Water Damage Monitoring and Response Plan, a Decommissioning Plan, a Groundwater Level Monitoring and Reporting Plan, Storm Water/Flood Control Protection Design Plans (ensuring protection from 100-year, 24-hour storms), and a Storm Water Pollution Prevention Plan ("SWPPP"). See table 5.1-1 Mitigation Plans to Minimize Environmental Impacts of Utility-Scale Solar Energy Facilities. [PEIS at 5-3.]

retention basins, detentions basins, debris basins and floodwater channels – that are necessary to protect not only the project itself but adjacent properties such as the BNSF mainline and ROW. BNSF strongly encourages BLM and DOE to incorporate standard mitigation measures within the Draft PEIS that require such hydrology studies to ensure that the BNSF mainline and ROW and other adjacent landowners are protected from the impact of future solar development projects.

B. Glint and Glare

Solar development projects employ a variety of technologies, to include parabolic mirrors and photovoltaic panels. These technologies have associated glint and glare which can have a direct negative impact on adjacent properties.[6] In addition to visual impact, some technologies – such as but not limited to SunCatchers and other parabolic mirror technologies – have known adverse health impacts to humans.[7]

BNSF's specific concerns relate to the health and safety of its train crews on its mainline travelling through the BNSF ROW. In addition to potential adverse health impacts to its train crews, BNSF is concerned that glare and glint from solar technologies could adversely impact its train crews ability to observe and respond to train signals. Both Federal Railway Administration ("FRA") regulations and the GCOR require BNSF to maintain visual contact with signals.

Accordingly, BNSF requests that BLM incorporate standard mitigation measures within the Draft PEIS to address these glare and glint impacts. BNSF suggests that at a minimum a buffer of at least two miles be created on either side of a rail right-of-way and any solar development project. In any case where an alternative to the establishment of a buffer is requested by a project proponent, BLM should require that site-specific, technology-specific glare and glint modeling be conducted, taking into account the terrain, the height and orientation of the rail line, the effect of the geometry of the track, the changes in elevation, the direction of travel, and the time of day and year on the magnitude and pattern of glare, among other factors. Such modeling should be taken into account prior to the finalization of site plans for the proposed solar development project. Affected railroads should be provided the opportunity to participate in such studies or offer rail-specific data and information on the project and its potential adverse impacts, including health impacts. Attached as ***Exhibit A*** hereto is a proposed Scope of Work for such a glare and glint study, which BNSF has proposed in connection with the Calico Solar

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[6] For example, the Calico Solar Final Environmental Impact Statement ("FEIS") issued by the BLM on August 6, 2010, found that a project may have an adverse impact if, among other things it would alter rail traffic or conflict with existing policies, plans, or programs. [FEIS 4-319 – 4-320.] The FEIS acknowledges the visual impacts to rail where it states: "From [the BNSF Railroad], the Proposed Action would create a strong degree of contrast. The magnitude of change from this viewpoint would be very high, and the Proposed Action would dominate the landscape." [FEIS 4-345.] The FEIS, however, does not address the potential for glint and glare to adversely affect the safety of rail operations and personnel on BNSF property adjacent to the proposed right-of-way for the Project. See also PEIS Section 5.12.2 at p. 5-175 through 5-191.]

[7] For example, studies have shown that, at a minimum, the offset for the employment of SunCatchers should be at least 223 feet to avoid adverse impact to human observers.

Project in San Bernardino County, California. BNSF believes this level of analysis of glare and glint impacts is critical to ensure that the BNSF employees, operations, mainline and ROW, and other adjacent landowners, are protected from the impact of future solar development projects.

C. Access Issues

Because of the unique nature of the pre-FLPMA ROW granted to BNSF for its mainline and rail operations, any crossing of the BNSF mainline, either at-grade or through a grade-separated crossing, has potential adverse impacts to the safety of BNSF train crews and to BSNF rail operations. Accordingly, BLM should explicitly exclude any access on, over, across or under any railroad right-of-way as part of a proposed solar energy project. Before any proposed solar development project is considered that envisions access onto or across the BNSF or other rail right-of-way, the proponent of the proposed solar development project should be required to coordinate directly with BNSF or other railroad and conduct all appropriate and necessary studies, to include hydrology and glint and glare studies, to ensure that any such crossing can be accomplished in a safe manner and without adversely impacting rail operations. Only after any access issues have been resolved at the discretion of the affected railroad should BLM consider the application.

5. Comments on Appendices

Appendix C. BNSF objects to BLM Land Use Pan Amendments under BLM Action Alternatives of the PEIS absent conditions such as affected areas exclude land within two miles of either side of any rail right-of-way, and the studies and mitigation measures identified above be implemented.

Appendix H. Please see comment above.

6. Conclusion

BNSF continues to support the need for site-specific plans as contemplated by the PEIS. "Many of the potential mitigation measures indicate the need for project-specific plans (see Table 5.1-1). The content of these plans will depend on specific project requirements and locations, and their applicability and effectiveness also needs to be evaluated at the project specific level. The authorizing agency or agencies (e.g., BLM, DOE, or state agencies) would need to determine the adequacy of such plans for specific projects. [PEIS 5-2]

For all the foregoing reasons, BNSF respectfully requests that the BLM supplement the Draft PEIS to include a general requirement that in connection with consideration of any solar development project, BLM make a finding that the particular technology proposed in that particular location will not result in adverse impacts, including health impacts, from glint and glare on rail employees, agents or contractors and operations, including a train crew's ability to accurately see and respond to signals. In addition, BNSF requests that the BLM include in the Draft PEIS the requirement that a solar project applicant: (1) perform comprehensive hydrology studies to determine project impacts on any rail line in the vicinity of the proposed project and implement appropriate mitigation measures on the project site; (2) perform a site-specific, and technology-specific glare and glint study to include modeling; (3) a subsidence monitoring plan and mitigation measures; (4) a thorough decommissioning/reclamation study and establish funding for the life of the project; (5) maintain emergency access for rail operations on the rail right-of-way; and (6) to the extent an applicant anticipates requiring access rights across, on, over or under a railroad right-of-way, secure such access rights directly with the applicable rail operator prior to submittal of an application for the solar development project.

Respectfully submitted,

/s/

Cynthia L. Burch
On Behalf of BNSF Railway

Exhibit A

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of:
The Application for Certification for the Calico Solar Power Project Licensing Case

Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF JOSEPH SCHNELL BNSF RAILWAY COMPANY

August 17, 2010

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Exhibit 1203

PREPARED DIRECT TESTIMONY

OF

Joseph Schnell

Manager Special Projects – Signal, BNSF

Q.1 Please state your name and occupation?

A.1 My name is Joseph Schnell. I am the Manager Special Projects – Signal, for BNSF Railway Company ("BNSF"). My resume is attached to this testimony.

Q.2 What is the purpose of your testimony in this proceeding?

A.2 I will testify transportation (glint and glare).

Q.3 Why does BNSF have concerns regarding the Calico Solar Project?

A.3 BNSF is one of two Class 1 railroads operating in California. BNSF's mainline, which is traversed by as many as 80 trains per day, carries interstate commerce from the Ports of Los Angeles and Long Beach to U.S. Midwestern, Southwestern and Eastern markets. BNSF's mainline has operated through the section of the proposed Project since the late 19th Century. Preliminarily, whether emplacing tens of thousands of SunCatchers immediately adjacent to both sides of one of only two strategic transcontinental transportation corridors for rail traffic from the west coast to all points east is a compatible use has not been addressed or analyzed. The proposed Project would surround both sides of several miles of BNSF's mainline tracks. Accordingly, BNSF has significant concerns that the construction and operation of the Project do not adversely impact BNSF operations or otherwise impose unacceptable safety risks to BNSF personnel and operations. BNSF must continue to maintain sole and independent discretion to ensure that its rail operations are safe and efficient. In addition, as a transcontinental railroad impacting interstate commerce, BSNF is subject to federal regulations and oversight.

The consummation of the Project would require the granting of several licenses and permits from BNSF, which Applicant Calico Solar ("Calico Solar") has requested in a piecemeal fashion over the course of the past year. To date, only preliminary access agreements have been granted. Before BNSF can grant such licenses and permits, BNSF must be assured that its significant safety and operational concerns are addressed.

Q.4 What are BNSF's safety and operational concerns in relation to transportation (glint and glare)?

A.4 BNSF's mainline, along which the Project is proposed to be built, is curved. An essential signal for rail traffic is located in the vicinity near Hector Road. Signals are critical safety features. Calico Solar's Project certification application seeks authority to emplace up to 34,000 SunCatchers within a 6,215 acre tract that falls on both sides of BNSF's right of way.

While there are no drawings or diagrams that specify precisely where the SunCatchers will be emplaced, Calico Solar proposes to locate the nearest SunCatchers as close as 100’ from the BNSF right of way, on both sides of the transcontinental mainline track, for approximately five miles.

Q.4 Why does the emplacement of the SunCatchers cause operational and safety concerns for BNSF?

A.4 Because daytime glint and glare from the 34,000 SunCatcher mirrors and associated structures, in particular when the mirrors are in offset tracking position, may significantly impact BNSF engineers' ability to see the signal. The situation would be exacerbated by the site elevations which Calico Solar has proposed.

Q.5 In addition to the safety concerns, are there federal regulations that govern signals?

A.5 Yes. BNSF is required by federal regulations and the Federal Railway Administration ("FRA") to maintain visual contact with signals. If a train's contact with a signal is lost and cannot be regained, the engineer is required to stop the train. This often requires an emergency application of the brakes, risking derailment of the train. When a train has been stopped through emergency application of the brakes, BNSF General Code of Operating Rule 6.23 requires the engineer to inspect all cars, units, equipment and track pursuant to BNSF special instructions and rules. This can cause significant delays to rail operations with ramifications reaching from the Ports of Los Angeles and Long Beach to Chicago and beyond.

Q.6 Have you had an opportunity to review the SSA Part II as it pertains to Traffic and Transportation (glare & glint)?

A.6 Yes.

Q.7 Does it adequately address BNSF's concerns?

A.7 No, it does not. To date, there is no study that has been performed that:

a. analyzes and measures the impact on BNSF rail operations;

b. analyzes and measures the glint and glare that will be produced from the SunCatchers in relation to the specifics heights, elevations, and angles relating to an engineer traveling along the curved track along the BNSF RoW;

c. ascertains what, if any, measures could be implemented to adequately mitigate the impact of the SunCatchers' glint and glare to ensure the safe operation of rail services along the BNSF RoW;

d. ascertains what evaluation, testing, coordination, and approval would be necessary to obtain government approval for any such mitigating measures.

Q.8 The SSA Part II represents at C.11-31 that "Staff has been working with representatives from BNSF Railways since July 16, 2010, to resolve BNSF Railway's concerns with glint and glare. As its usual procedure, staff commissioned a glint and glare study, which is attached to this document." Has that occurred?

A.8 Somewhat, but that is, at best, incomplete. Initially, the study did not address the rail safety and operational issues raised by BNSF. We were told that Staff was going to expand the scope of its glare/glint study to address these issues. In a call facilitated by CEC Staff person Marie McLean, I initially spoke with Cliff Ho of Sandia labs. Mr. Ho explained that he had been asked to perform some calculations to determine what the appropriate safe distance was from the SunCatcher for a motorist. His work was not specific to the Calico Solar facility, nor did it address rail operations and safety. Ms. McLean then facilitated a second call, to James Jewell, the consultant retained by Staff to head the study. Mr. Jewell requested information from BNSF that he represented was essential for him to complete his study. Attached hereto as Exhibit "A" is a string of emails that started on July 29, 2010 from Mr. Jewell. In his July 29th email, Mr. Jewell asked BNSF to provide him with information regarding:

1. height of signal poles,
2. height of the mid-point of the signal above the track,
3. height of the eyes of the average engineer above the track,
4. distance from a signal pole at which an engineer is expected to recognize and act upon a signal,
5. average width or consistent width of the BNSF ROW, and
6. number and location of signal poles within the solar plant area and just before or after the plant boundary.

Mr. Jewell represented that he needed this information to "establish the viewing angles and distances and then to discern just which signals may be seen against the SunCatcher mirrors and at what angular relationships. All of this information will make it possible for me to establish the requirements of a study."

Accordingly, as can be seen from the string of emails, there is no glare/glint study that addresses the issues raised by BNSF and confirmed as appropriate for a study by CEC's own consultant.

Q.9 Was the requested information provided to Mr. Jewell?

A.9 In part. We began providing the requested information but received an email from Mr. Jewell on August 3, 2010, stating "the Commission staff (including me) will not work on this further since there is a COC requiring collaboration on a solution. But there will be a 'workshop' and I will, . . . Be Prepared. Thanks for all your help. I think I can help at the workshop." [See Exhibit "A."]

Q.10 When did you receive the SSA Part II?

A.10 August 9, 2010.

Q.11 Were you surprised when you read it?

A.11 Absolutely. The SSA Part II could be misread and misinterpreted to read as if BNSF fully participated, there was a study performed to address the specific rail safety and operations concerns raised by BNSF, we came to an agreement, and BNSF is satisfied that its safety concerns have been addressed and will be mitigated. That did not happen. We were told that Mr. Jewell was going to prepare a study that analyzed the glare and glint issue in relation to the unique angles and field of vision that an engineer would encounter while traveling along the RoW. We provided information that Mr. Jewell represented he needed to perform his study. That information was not used or referenced in the study. Then Mr. Jewell sent us an email saying no further work would be done and that we would collaborate on a solution. He said there would be a workshop. There was no workshop.

Q.12 The SSA Part II states at C.11-31 that "staff reviewed the glint and glare study and mitigation measures with BNSF Railway representatives. The review included telephone conversations with Energy Commission glint and glare consultants to ensure BNSF Railway's concerns were addressed." Were BNSF's concerns addressed.

A.12 First of all, the telephone conversations with the CEC consultants took place without the benefit of a draft report or any supporting information or consultants. While we were told it would be available before the issuance of the Supplemental Staff Report, that did not occur. Accordingly, the conversations were very general in nature and did not address BNSF's specific concerns. Because no study had been performed, there was no meaningful discussion regarding mitigation measures. At the time that the CEC decided that it would not perform its own study to address BNSF's rail safety issues and concerns, we were advised that CEC was going to require: (1) a 300 foot setback from the edge of the BNSF RoW for the closest SunCatcher; (2) a site-specific study on the effects of the SunCatcher's glint and glare on BNSF's safety, operations and signals, funded by Calico Solar; and (3) workshops to be held to resolve BNSF's concerns. The CEC also offered to assist BNSF find a glint/glare expert with appropriate expertise. Moreover, we only had a little over a week between the issuance of the SSA Part II and the hearing. This is not adequate time to address all of the issues raised for the first time in the SSA Part II. When I actually read TRANS-7 it was clear that BNSF's concerns had not been addressed and that conclusions had been drawn about purported mitigation measures that were not based on any actual scientific study. We consistently told the Commission and Calico Solar that before BNSF can consider approving any further access to the BNSF RoW, the following Condition of Certification must be incorporated into the Project:

> Prior to the first SunCatcher disc being mounted on a pedestal, a site-specific Glare/Glint study shall be performed at Calico Solar's expense to address the Glare/Glint issues raised by BNSF with respect to the potential impact of the proposed Calico Solar SunCatchers on BNSF rail operations. The recommended mitigation measures shall be reviewed by BNSF. If BNSF approves the recommended mitigation measures, they will be

implemented by Calico Solar at its expense. The site specific study shall commence immediately upon BNSF's selection of the experts to perform the study.

Q.13 The SSA Part II also states at C.11-32 that "BNSF Railway's representatives also expressed a concern about glint and glare and its effects upon the railroad engineer's ability to correctly perceive the color of the signal. Through several telephone conversations, staff and commission's glint and glare consultants discussed with BNSF Railway representatives their specific concerns about the signal lights. Staff determined that measures exist, if needed, to ensure that BNSF Railway engineers will be able to correctly perceive the color of the signal. Those procedures involve hooding and increasing the intensity of the lights." Is that accurate?

A.13 No. Again, as stated above, we only had two general conversations with the CEC consultants. We talked about our concern about seeing the signal, identifying the color of the signal, being able to identify the signal if the background consisted of thousands of mirrored surfaces, our concerns regarding "phantom signals" where the light reflected inside the signal gives a false reading that the signal is on, and a potential "funhouse" effect where a signal is reflected in a mirror that is one of a bank of thousands of mirrors and gives the false appearance that it is in a location other than the one it is actually in. We consistently told the Commission and its consultants that BNSF must exercise its independent judgment to protect the safety and operations of its transcontinental rail system. Some of the options that might be considered after a thorough study of the potential impact on rail safety and operations of Calico Solar's proposed facility on BNSF may, in addition, require federal government approval. BNSF has specifically advised CEC's consultant, pending ongoing studies in other arenas, it did not know if signal light strength could be increased or if alternative methods of "hooding" a signal would help the engineer identify the signal. To date, I have seen no studies or technical data regarding hooding, increased light signal strength, use of LED lights, or other signal mitigation measures that would support Staff's conclusions in this regard.

Q.14 Does this complete your direct testimony?

A.14 Yes, it does.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: August 16, 2010

Joseph Schnell

Joseph D. Schnell

669 Cattlemans Way
Fort Worth, TX 76131
(425) 213-7284
Joseph.Schnell@BNSF.com

Education:

Electrical Engineering Degree with emphasis in Electronics and Management, University of Nebraska-Lincoln, Lincoln, Nebraska
Graduation Date: May 2006

Internship Experience:

Summer 2005: Engineering Intern, Burlington Northern Santa Fe Railway, based in Amarillo, Texas.
Duties included traveling across Texas, Oklahoma and Kansas working with different level employees within the signal department in the areas of construction and maintenance.

May 2004 to December 2004: Project Engineer Co-op, Nebraska Public Power District, Beatrice Power Station, Beatrice, Nebraska.
Duties included functional location tagging, document control, and database management.

Summer 2003: Technical Director Management Intern, General Electric Transportation Systems, Bailey Yard, North Platte, Nebraska.
Duties included heading up EOA satellite communications system implementation, numerous software upgrades, and quality control projects. Completed first step of six sigma training.

Research Experience:

January 2003 to May 2004: Undergraduate Research, Centre of Electro Optics, University of Nebraska-Lincoln.
Performed laser induced breakdown spectroscopy research under Dr. Dennis R Alexander.

Volunteer Experience:

February 2002 to May 2006: Teachers Aide, Norwood Park Elementary School, Lincoln, Nebraska.
Helped with clerical work, assisted with teaching, and worked one-on-one with students in the areas of reading, math and English.

Honors and Awards:

Passed Fundamentals of Engineering Exam, October 2005
Holling Memorial Scholarship, 2005
VIP Outstanding Volunteer Award, 2003
UNL Undergraduate Creative Activities and Research Experiences Award, 2003
UNL Engineering Departmental Scholarship, 2001
UNL Canfield Scholarship, 2001

BNSF Experience:

April 2010 to Present: Manager Special Projects – Signal, Fort Worth, Texas.
As the manager of special projects, I am responsible for the signal departments reporting to the FRA, as well as notifications to the BRS. I manage several databases and sections for the signal scorecard and website. Along with these duties I manages other engineering projects such as power line mitigation, work equipment issues, and other issues the directly effect the signal department.

February 2009 to April 2010: Supervisor Signals, Vancouver, Washington.
I made a developmental move to coordinate the signal maintenance activities on the Fallbridge, Yakima Valley and Stampede Subdivisions. In making that move I was afforded the opportunity to expand my knowledge base and improve my skills as a supervisor. During my as the Vancouver supervisor I became intimately knowledgeable in CTC signaling, as well as educated in train operations on high traffic lines. I have planned windows around and with major production gangs and for pole line contractors. On the construction side I have surveyed several crossings and solar locations for pole line removal. I have also been fortunate in that I was able to participate in several major cut-over's with our Northwest Signal Construction team.

I was also given the opportunity to attend an FLS forum at Garret Creek Ranch. During my time at the forum was able to give input on everything from manpower issues to our current computer system.

April 2007 to February 2009: Supervisor Signals, Bend, Oregon.
Duties have included the coordination of maintenance activities on the Oregon trunk and Gateway sub-divisions through the Maintenance Excellence system. Included within this system are managing a capital and operating budget, keeping up on FRA mandated testing, tracking service bulletin upgrades, managing vehicle maintenance and upkeep, ordering and tracking material and coordinating the training and progression of my team.

My main two focal points while in Bend have been team development and physical plant improvement. The Signal Team lacked cohesiveness and a proper sense of direction, but has now developed into a real team with focused job priorities. We have been able to improve numerous crossings with new installations of motion sensing devices, event recorders, and gate mechanisms. We have also upgraded commercial power service and standby power across the board, improving reliability greatly.

I have attended a management trainee forum at Garret Creek Ranch and become a part of the recruiting team for the University of Nebraska-Lincoln. I am also scheduled to begin the signal apprentice classes in the fall of 2008.

December 2006 to April 2007: Assistant Supervisor Signals Construction, Northwest Division based out of Seattle, Washington.
Duties included working on signal construction projects with the Northwest signal construction team, as well as spending time assisting maintenance supervisors with projects and vacation relief. Notable projects worked on are listed as follows:

- Crossing installations in Bellingham, Washington
- Electrocode upgrades in New Westminster, British Columbia
- Electrocode upgrades on the Fallbridge subdivision, Wishram, Washington
- Electrocode upgrades, switch upgrades and crossing upgrades in the Vancouver Yard, Vancouver, Washington
- Running signal crews during the 2007 Fallbridge Maintenance Blitz, Vancouver, Washington to Pasco, Washington

Time was spent surveying projects, working with crew foremen on scheduling construction activities, overseeing construction and pre cut-over breakdowns, helping to plan and run cutovers and in-servicing projects.

June 2006 to December 2006: Management Trainee, Completed formal training in Ft. Worth, Texas and Kansas City, Kansas with the engineering department.
Finished a six month management trainee program under Signal Manager Doug Proffitt in Seattle, Washington. Duties included completing cross-departmental training, as well as reaching set goals for training within the signal department.

BNSF Formal Training
Engineering Frontline Supervisor, June 2010
Engineering Frontline Supervisor, July 2009
Engineering Frontline Supervisor, June 2008
Engineering Frontline Supervisor, September 2007
Formal Investigation Training, May 2007
Fast Track Signal Training Program, January 2007
Engineering Operations Testing, December 2006
Leading People Successfully Engineering Part 2, November 2006
Engineering Frontline Supervisor, October 2006
Functional Engineering, September 2006
Supervisor FRA Track Safety, August 2006

From: James Jewell [mailto:jjewell@arch-light.com]
Sent: Tuesday, August 03, 2010 11:41 AM
To: Alexander, Anne
Subject: Re: BNSF/Calico - Large Scale Map and Additional Measurement

ANNE -- You have been a great help. As you probably know the Commission staff (including me) will not work on this further since there is a COC requiring collaboration on a solution. But, there will be a "workshop" and I will, as they are saying at the Jamboree this week in Virginia, Be Prepared. Thanks for all the data. I think I can help at the workshop. JAMES

On 8/3/10 11:07 AM, "Alexander, Anne" <anne.alexander@kattenlaw.com> wrote:

All:

Attached is an electronic version of a map of the BNSF right of way requested last week. Also, our client has informed us that the distance at which an engineer needs to be able to

Exhibit "A" to Schnell

see a signal is 1500 feet. Please let us know if you need anything else.

Anne

ANNE ALEXANDER
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From: Alexander, Anne
Sent: Friday, July 30, 2010 3:30 PM
To: 'jjewell@arch-light.com'; 'alindsley@lindsleylighting.com'
Cc: 'Mmclean@energy.state.ca.us'; 'Dflores@energy.state.ca.us'; Burch, Cynthia Lea; Lamb, Steven A.
Subject: BNSF/Calico - Additional Measurements

James and Alan:

Again, we very much appreciate the quick turnaround on information requests. I am restating below the measurements from the signal head to the ground for the two signals at Hector Road (one signal for each track) which we sent yesterday, and have added some of the other information you requested yesterday. The height of the mid-point of the signal above the track would be the height of the yellow signal.

Main Track 1
Green signal to grade 30' 9"
Yellow signal to grade 29' 9"
Red signal to grade 28' 9"
Rail to grade 10'
Thus:
Green signal to rail: 20' 9"
Yellow signal to rail: 19' 9"
Red signal to rail: 18' 9"

Main Track 2
Green signal to grade 30'
Yellow signal to grade 29'
Red signal to grade 28'
Rail to grade 9'
Thus:

Green signal to rail:	21'
Yellow signal to rail:	20'
Red signal to rail:	19'

The engineer's eyes will be between 13 and 14 feet off the tracks. The width of the right of way is 100 feet through the project. There are a total of two signal poles within the Project site. We will provide you the distance from a signal pole at which an engineer is expected to recognize and act upon a signal on Monday.
Please do not hesitate to contact us with further questions or requests for information.

Have a great weekend,
Anne

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From: Burch, Cynthia Lea
Sent: Thursday, July 29, 2010 2:43 PM
To: 'jjewell@arch-light.com'; Alexander, Anne
Cc: 'Mmclean@energy.state.ca.us'; 'alindsley@lindsleylighting.com'; 'Dflores@energy.state.ca.us'
Subject: Re: BNSF/Calico

James, thank you forquick turn around on data requests. We will forward them to BNSF.
Cynthia

From: James Jewell
To: Burch, Cynthia Lea
Cc: Marie McLean ; Lindsley, AIA, IESNA Alan ; David Flores
Sent: Thu Jul 29 12:45:18 2010

Subject: BNSF/Calico

CYNTHIA — It was good to talk with you, Steve Ramsey, and the representative of BNSF. In our extended conversation there was some data that I didn't get to ask for so that I might make an initial estimate of the view angles involved. The conversation was helpful in that the applicants drawings do not show a double track installation.

I'll be away until Saturday, but perhaps your office or BNSF could send this along so I have it over the weekend. My colleague Alan Lindsley, who has been the lead light and vision consultant on Calico SPP, may have some further questions. If we can establish clearly the viewing angles, we may be able to predict and restrict the points of visual conflict for trainmen.

The following would be helpful:

1) height of the signal poles,
2) height of the mid-point of a signal above the track,
3) height of the eyes of the average engineer above the track; that is cab floor height plus seated viewer height,
4) distance from a signal pole at which an engineer is expected to recognize and act upon a signal,
5) average width or consistent width of the BNSF ROW, and
6) number and location of signal poles within the solar plant area and just before or after the plant boundary.

I think you can see that I want to establish the viewing angles and distances and then to discern just which signals may be seen against the Suncatcher mirrors and at what angular relationships. All of this information will make it possible for me to establish the requirements of a study. Thanks for your help. JAMES

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION

For the CALICO SOLAR (Formerly SES Solar One)

Docket No. 08-AFC-13

PROOF OF SERVICE
(Revised 8/9/10)

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*indicates change

DECLARATION OF SERVICE

I, Harriet Vletas, declare that on August 17, 2010, I served and filed copies of the attached Prepared Direct Testimony of Joseph Schnell, BNSF Railway Company, dated August 17, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:
[www.energy.ca.govlsitingcaseslsolarone].

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

_x__ sent electronically to all email addresses on the Proof of Service list;

___ by personal delivery;

___ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

_x__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

___ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 08-AFC-13
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

Harriet Vletas
HARRIET VLETAS

*indicates change

31532494_2.DOC

Exhibit B

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of: The Application for Certification for the Calico Solar Power Project Licensing Case	Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF DENNIS SKEELS
BNSF RAILWAY COMPANY

August 17, 2010

Cynthia Lea Burch
Steven A. Lamb
Anne Alexander
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anne.alexander@kattenlaw.com

Attorneys for Intervenor
BNSF Railway Company

Exhibit 1204

PREPARED DIRECT TESTIMONY

OF

Dennis Skeels

Manager Signals California Division – BNSF

Q.1 Please state your name and occupation?

A.1 My name is Dennis Skeels. I am the Manager Signals, California Division, for BNSF Railway Company ("BNSF"). My resume was attached to my previous testimony.

Q.2 What is the purpose of your testimony in this proceeding?

A.2 I will testify regarding transportation (glint and glare).

Q.3 Why does BNSF have concerns regarding the Calico Solar Project?

A.3 BNSF is one of two Class 1 railroads operating in California. BNSF's mainline, which is traversed by as many as 80 trains per day, carries interstate commerce from the Ports of Los Angeles and Long Beach to U.S. Midwestern, Southwestern and Eastern markets. BNSF's mainline has operated through the section of the proposed Project since the late 19^{th} Century. Preliminarily, whether emplacing tens of thousands of SunCatchers immediately adjacent to both sides of one of only two strategic transcontinental transportation corridors for rail traffic from the west coast to all points east is a compatible use has not been addressed or analyzed. The proposed Project would surround both sides of several miles of BNSF's mainline tracks. Accordingly, BNSF has significant concerns that the construction and operation of the Project do not adversely impact BNSF operations or otherwise impose unacceptable safety risks to BNSF personnel and operations.

The consummation of the Project would require the granting of several licenses and permits from BNSF, which Applicant Calico Solar ("Calico Solar") has requested in a piecemeal fashion over the course of the past year. To date, only preliminary access agreements have been granted. Before BNSF can grant such licenses and permits, BNSF must be assured that its significant safety and operational concerns are addressed.

Q.4 What are BNSF's safety and operational concerns in relation to transportation (glint and glare)?

A.4 BNSF's mainline, along which the Project is proposed to be built, is curved. An essential signal for rail traffic is located in the vicinity near Hector Road. Signals are critical safety features and engineers must be able to see signals in sufficient time to respond accordingly to avoid potentially life-threatening events such as a derailment. Calico Solar's Project certification application seeks authority to emplace up to 34,000 SunCatchers within a 6,215 acre tract that falls on both sides of BNSF's right of way.

While there are no drawings or diagrams that specify precisely where the SunCatchers will be emplaced, Calico Solar proposes to locate the nearest

SunCatchers as close as 223' from the BNSF right of way, on both sides of the transcontinental mainline track, for approximately five miles.

Q.5 Why does the emplacement of the SunCatchers cause operational and safety concerns for BNSF?

A.5 Because daytime glint and glare from the 34,000 SunCatcher mirrors and associated structures, in particular when the mirrors are in offset tracking position, may significantly impact BNSF engineers' ability to see the signal. The situation would be exacerbated by the site elevations which Calico Solar has proposed. Additionally, refracted light radiating back from the SunCatchers could possibly introduce a light source that may cause a signal to display an aspect more favorable than what is intended. This can result in a phantom signal. Attached hereto as Exhibits "A" and "B" are photos showing a phantom signal.

Q.6 In addition to the safety concerns, are there federal regulations that govern signals?

A.6 Yes. BNSF is required by federal regulations and the Federal Railway Administration (the "FRA") to maintain visual contact with signals. If a train's contact with a signal is lost and cannot be regained, the engineer is required to stop the train. This often requires an emergency application of the brakes, risking derailment of the train. When a train has been stopped through emergency application of the brakes, BNSF General Code of Operating Rule 6.23 requires the engineer to inspect all cars, units, equipment and track pursuant to BNSF special instructions and rules. This can cause significant delays to rail operations with ramifications reaching from the Ports of Los Angeles and Long Beach to Chicago and beyond.

Q.7 Have you had an opportunity to review the SSA Part II relating to traffic and Safety (Glint and Glare)?

A.7 Yes, I have.

Q.8 Does it adequately address BNSF's concerns?

A.8 No, it does not. To date, there is no study that has been performed that:

a. analyzes and measures the impact on BNSF rail operations;

b. analyzes and measures the glint and glare that will be produced from the SunCatchers in relation to the specifics heights, elevations, and angles relating to an engineer traveling along the curved track along the BNSF Right of Way ("RoW");

c. ascertains what, if any, measures could be implemented to adequately mitigate the impact of the SunCatchers' glint and glare to ensure the safe operation of rail services along the BNSF RoW;

d. ascertains what evaluation, testing, coordination, and approval would be necessary to obtain FRA approval for any such mitigating measures.

Q.9 Are there signals in the vicinity of the proposed Project that would be impacted by the project?

A.9 Yes, there are. Attached hereto as Exhibit "C" is an extract from a Track Chart, Needles Subdivision, which shows the locations of the signals in the proposed Project area. Starting on the page denoted with a circled 8 at the top right corner and reflecting mile markers 710 through 715 and then the following page denoted with a circled 9 at the top right corner and reflecting mile markers 705 through 710, these are the pages that relate to the proposed Project site. Various features are pointed out, to include train speed, crossings, signals, and hot box detectors, as well as curves and grade. As you can see, train speed varies based on whether it is freight or passenger and also varies based on the grade and curves. There are currently two crossings, one near Hector and one near West Pisgah. The Hector crossing has a signal before and after the crossing. The West Pisgah crossing has several signals on either side of the crossing and is near a 2 degree 10 minute turn.

BNSF is also concerned that the SunCatchers may impact the signals and hot boxes along the mainline because the signals and hotboxes are solar-powered. Accordingly, if the SunCatchers are too close to the mainline, the shadow from the SunCatchers could shade the signals and hotboxes, thereby eliminating their energy source and causing failure or malfunction. BNSF understands that Calico Solar has agreed not to emplace any SunCatcher within 223 feet of the RoW, which would mitigate this issue.

Finally, there is always a concern regarding transmission lines interfering with signals. BNSF understands that Calico Solar has agreed not to emplace any transmission line within 300 feet of the RoW and to only cross the RoW at a right angle sufficiently distant from a signal, thereby mitigating this issue.

Q.10 Does the SSA Part II account for the signals?

A.10 No. I am not aware of any maps or drawings that show the signals and the SSA Part II does not make any reference to where the signals are located.

Q.11 Based on these stated concerns, what is BNSF's proposal in relation to the glare and glint issue?

A.11 Before BNSF can consider approving any further access to the BNSF RoW, the following Condition of Certification must be incorporated into the Project:

> Prior to the first SunCatcher disc being mounted on a pedestal, a site-specific Glare/Glint study shall be performed at Calico Solar's expense to address the Glare /Glint issues raised by BNSF with respect to the potential impact of the proposed Calico Solar SunCatchers on BNSF rail operations. The recommended mitigation measures shall be reviewed by BNSF. If BNSF approves the recommended mitigation measures, they will be implemented by Calico Solar at its expense. The site specific study

shall commence immediately upon BNSF's selection of the experts to perform the study.

Q.12 The SSA Part II at C.11-36-37 makes reference to signal light modifications. Have you reviewed it?

A.12 Yes, I have.

Q.13 Are the suggested modifications feasible?

A.13 SSA Part II at C.11-36 refers to "current LED signal technology." Based on my extensive experience, I am not aware of any such current approved LED signal technology. BNSF is currently conducting testing of LED signal lights, but there presently is no standard LED signal that has been tested and approved for use by BNSF. Moreover, shielding or hooding of signals requires coordination with federal authorities before we make any changes.

Q.14 Does this complete your direct testimony?

A.14 Yes, it does.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: August 17, 2010

Dennis Skeels
Dennis Skeels

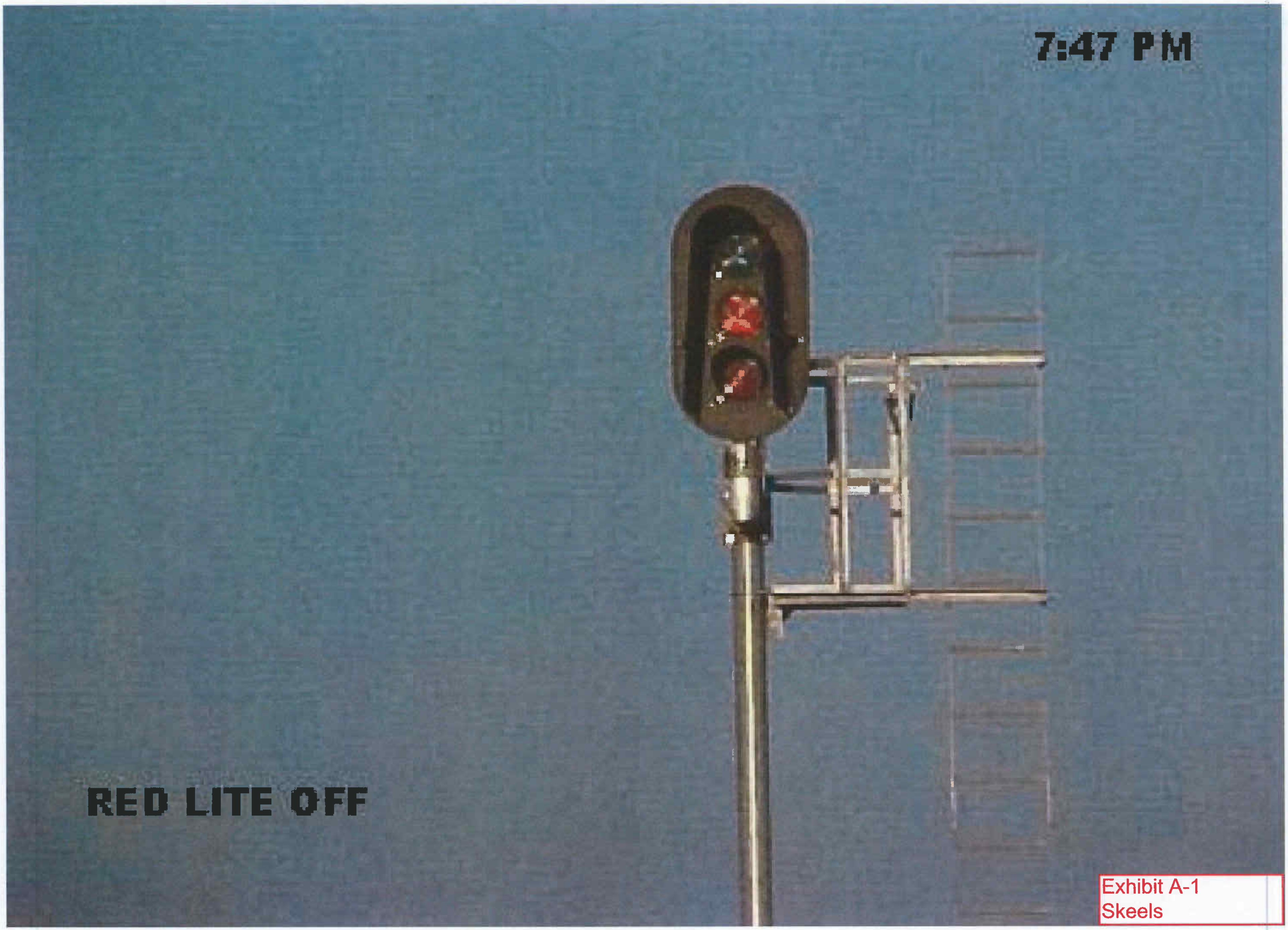
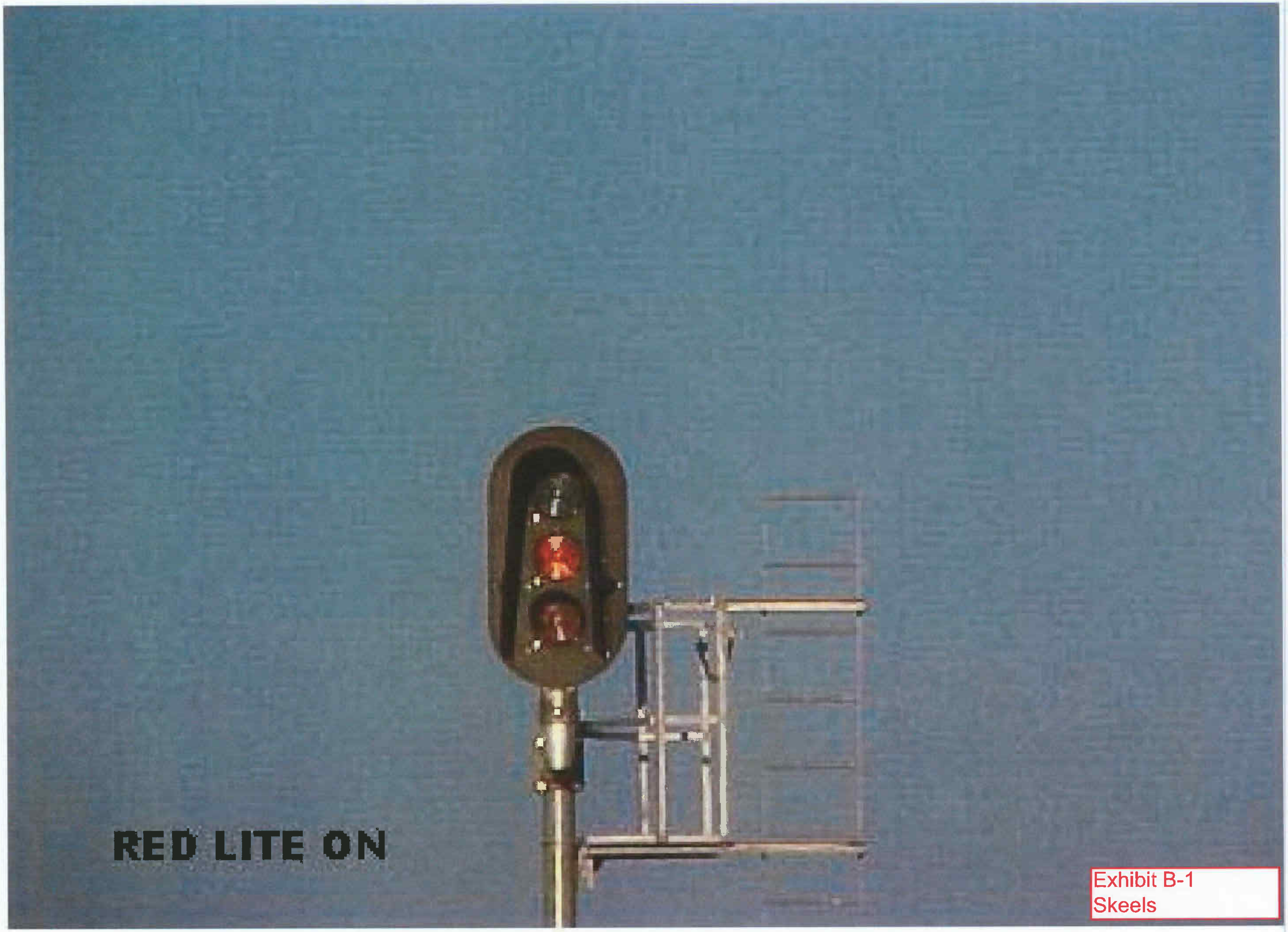


Exhibit A-1
Skeels

Exhibit A-2
Skeels


RED LITE ON
Exhibit B-1
Skeels

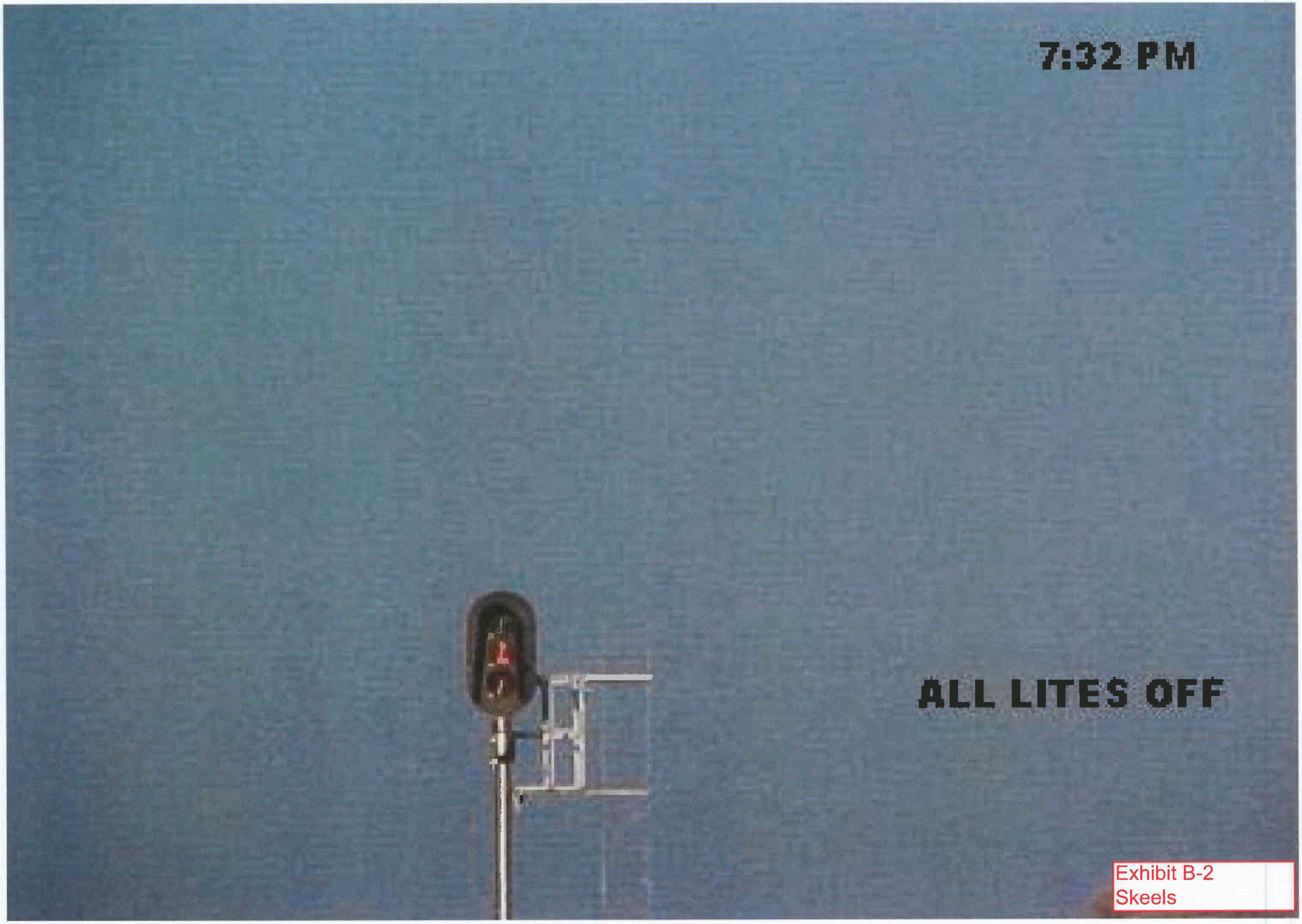


Exhibit B-2
Skeels

BNSF RAILWAY

Track Chart

Needles Subdivision

Needles, CA (M.P. 578.0) to Barstow, CA (M.P. 745.83)

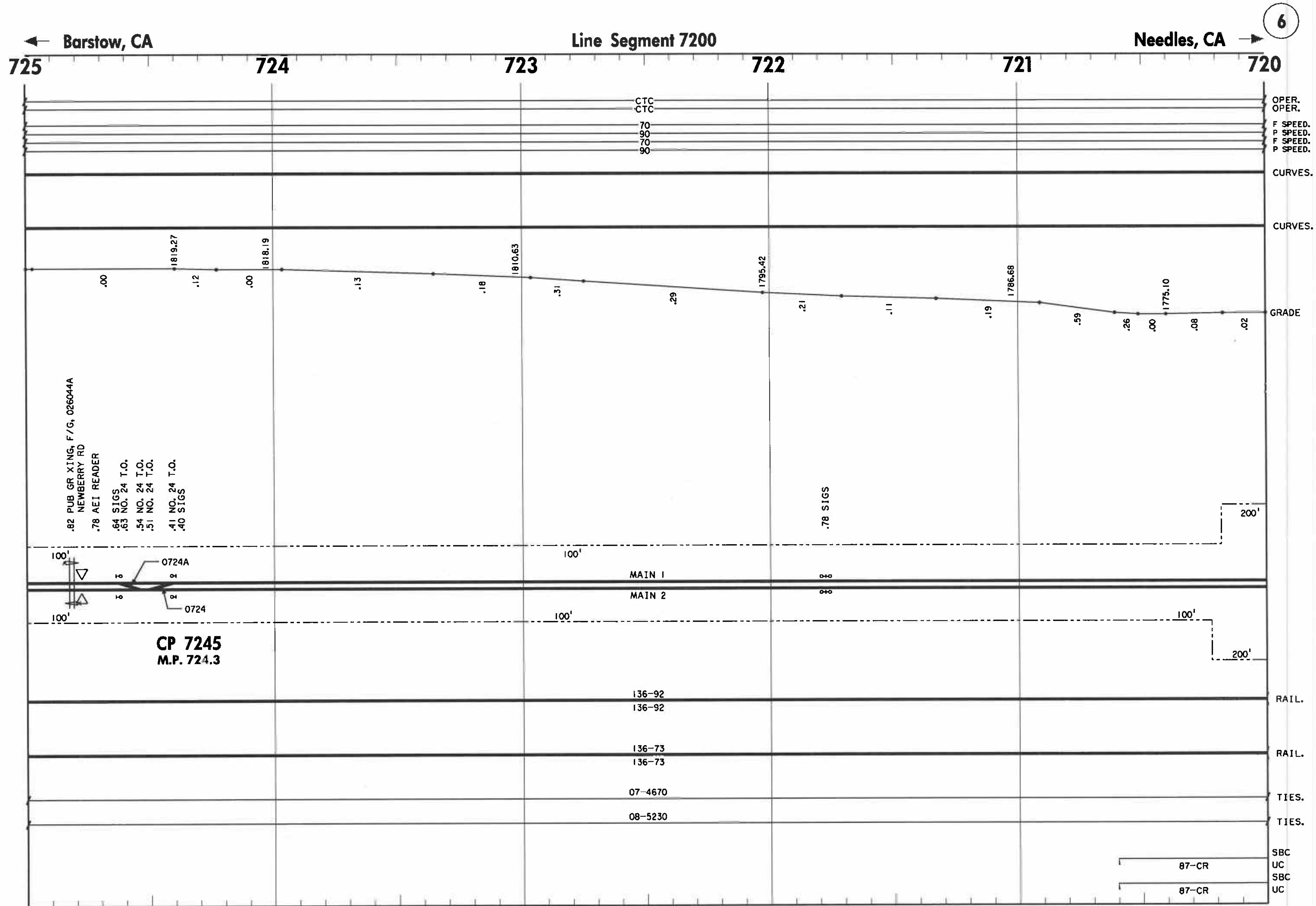
See each page for latest revised date

To view on the intranet or print this Track Chart go to:
http://kcintvpd0001.iss.bnr.com/maprec/mapsrechome.htm

To order this Track Chart in Sourcenet or
Millennium, use: 1363651

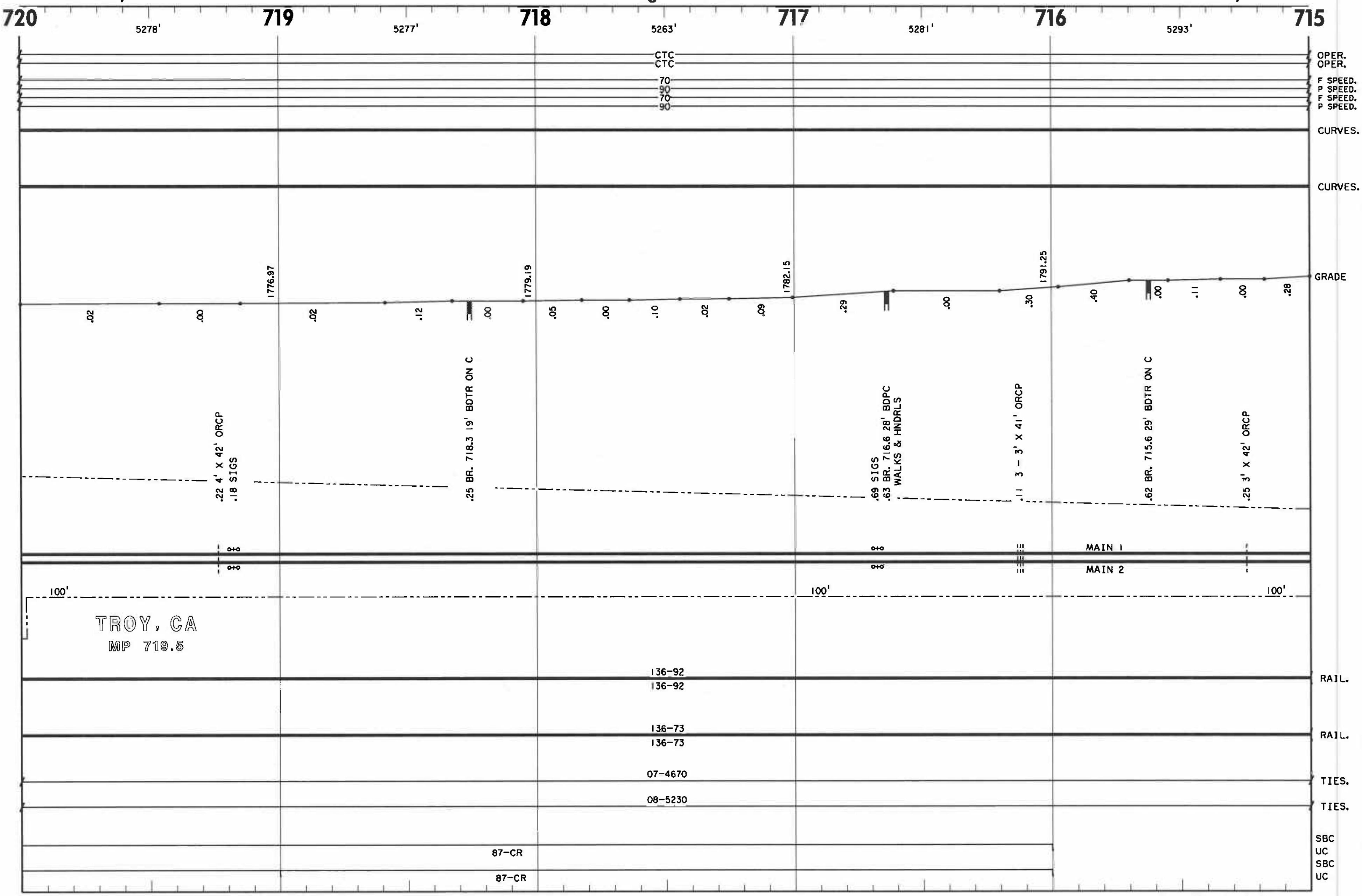
If you have any corrections or changes to these pages,
either mail to the Manager of Maps and Records at
4515 Kansas Ave., Kansas City, KS 66106 or FAX to
913-551-4285. Mailing is preferred.

Notes:

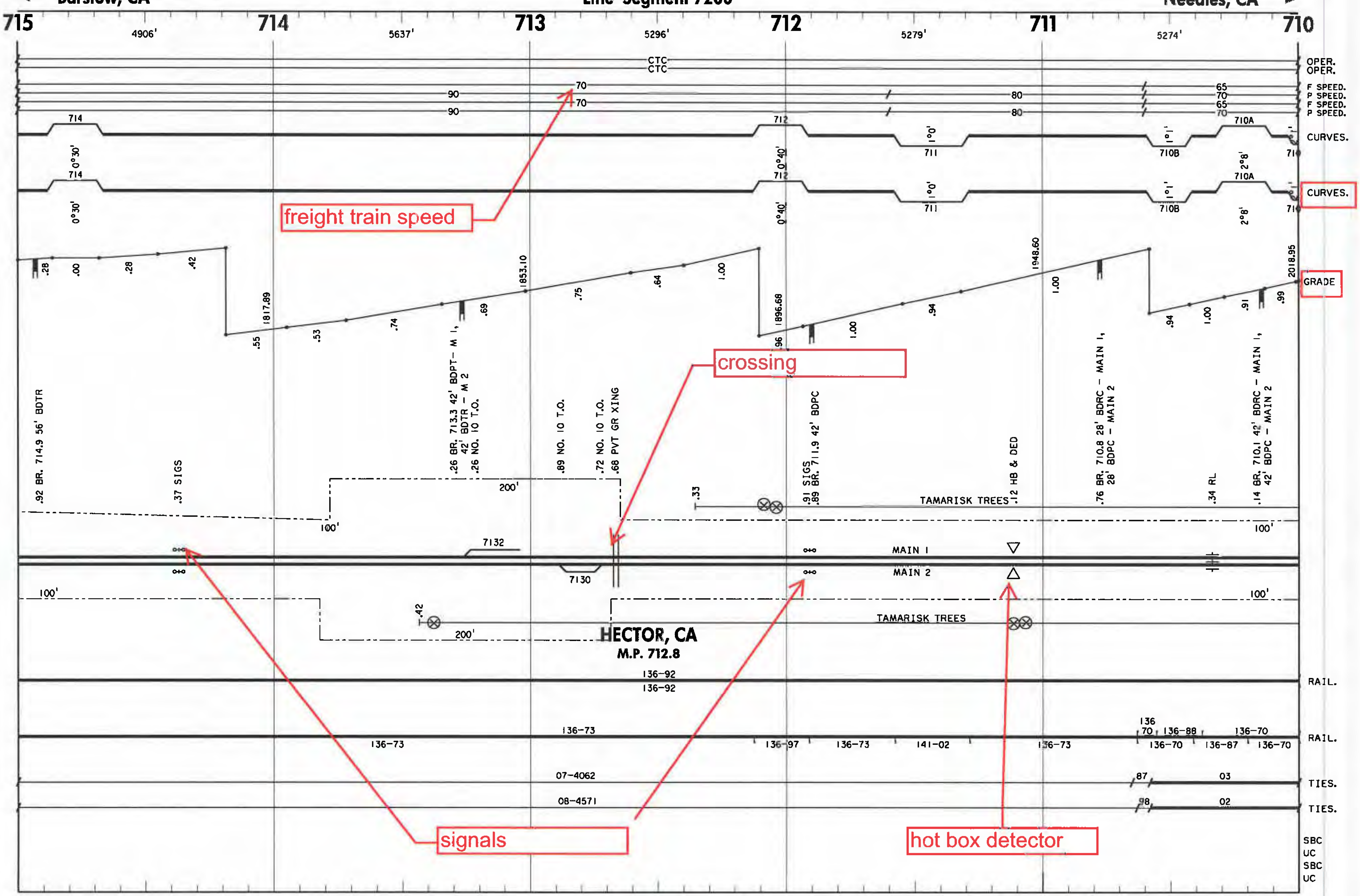


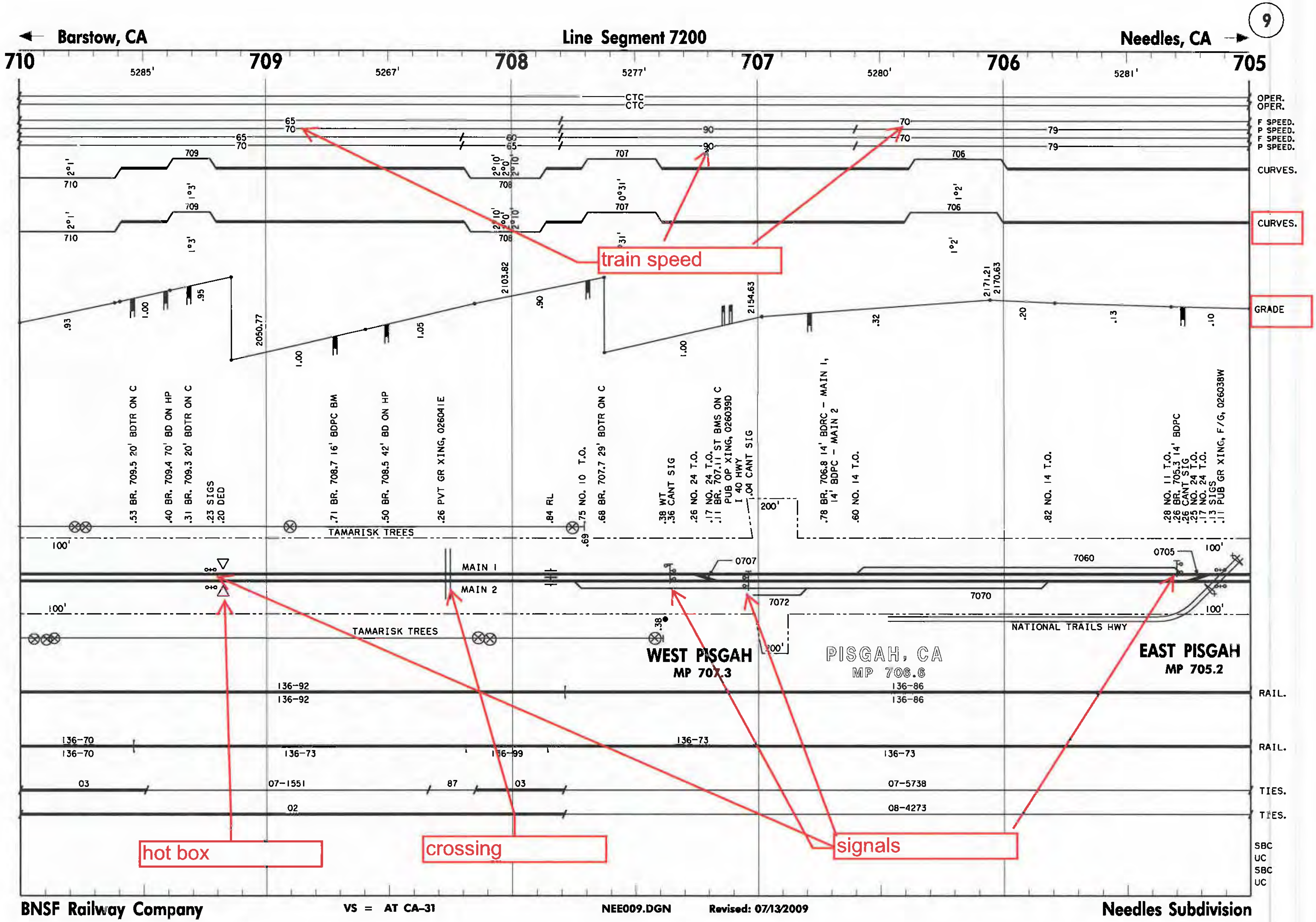
← Barstow, CA
Line Segment 7200
Needles, CA →
725
724
723
722
721
720
CTC
CTC
70
90
70
90
OPER.
OPER.
F SPEED.
P SPEED.
F SPEED.
P SPEED.
CURVES.
CURVES.
GRADE
1819.27
1818.19
1810.63
1795.42
1786.68
1775.10
.00
.12
.00
.13
.18
.31
.29
.21
.11
.19
.59
.26
.00
.08
.02
.82 PUB GR XING, F/G, 026044A
NEWBERRY RD
.78 AEI READER
.64 SIGS
.63 NO. 24 T.O.
.54 NO. 24 T.O.
.51 NO. 24 T.O.
.41 NO. 24 T.O.
.40 SIGS
.78 SIGS
0724A
0724
MAIN 1
MAIN 2
100'
100'
100'
100'
100'
200'
200'
CP 7245
M.P. 724.3
136-92
136-92
136-73
136-73
07-4670
08-5230
RAIL.
RAIL.
TIES.
TIES.
SBC
UC
SBC
UC
87-CR
87-CR

← Barstow, CA | Line Segment 7200 | Needles, CA →

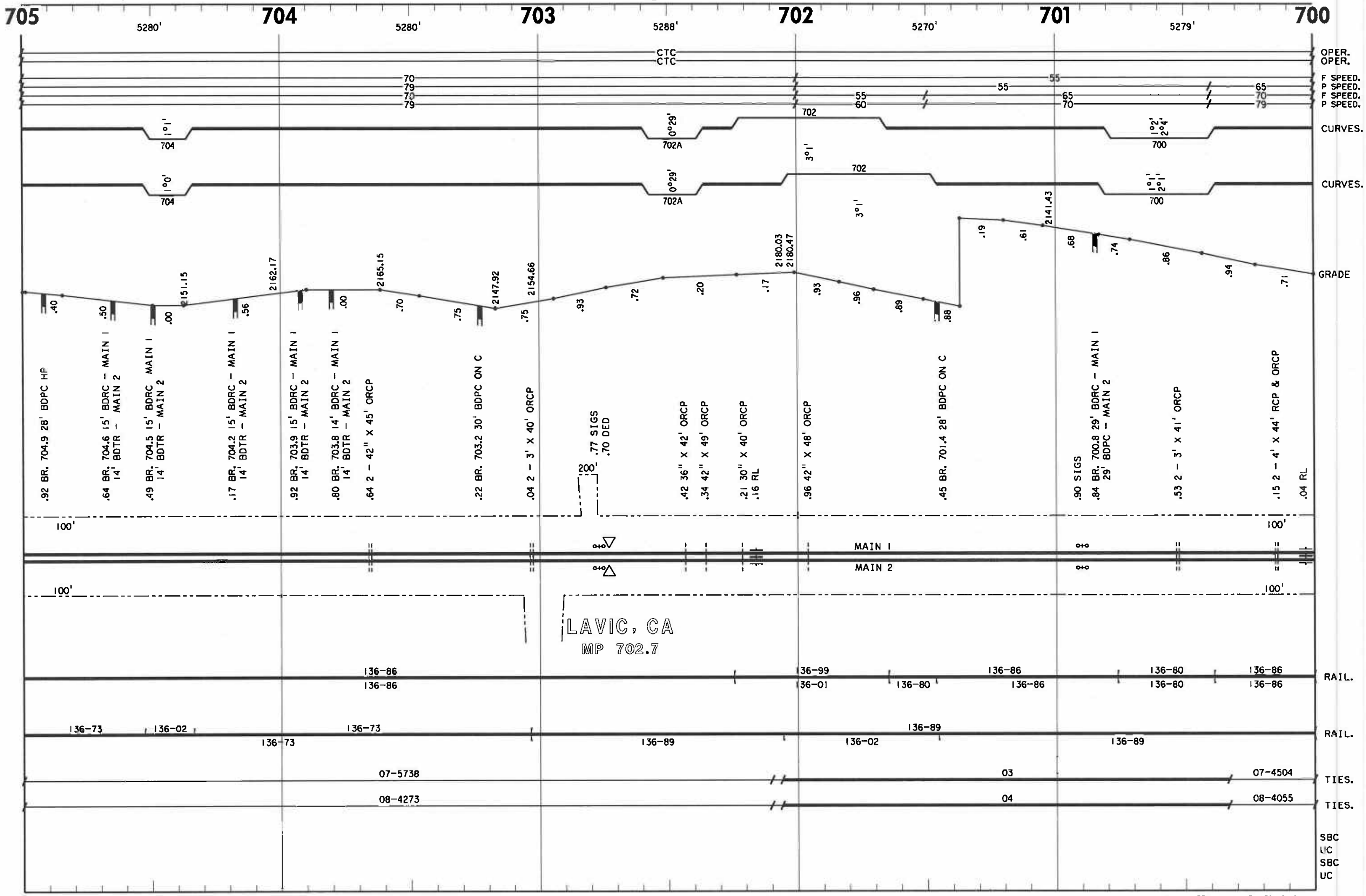


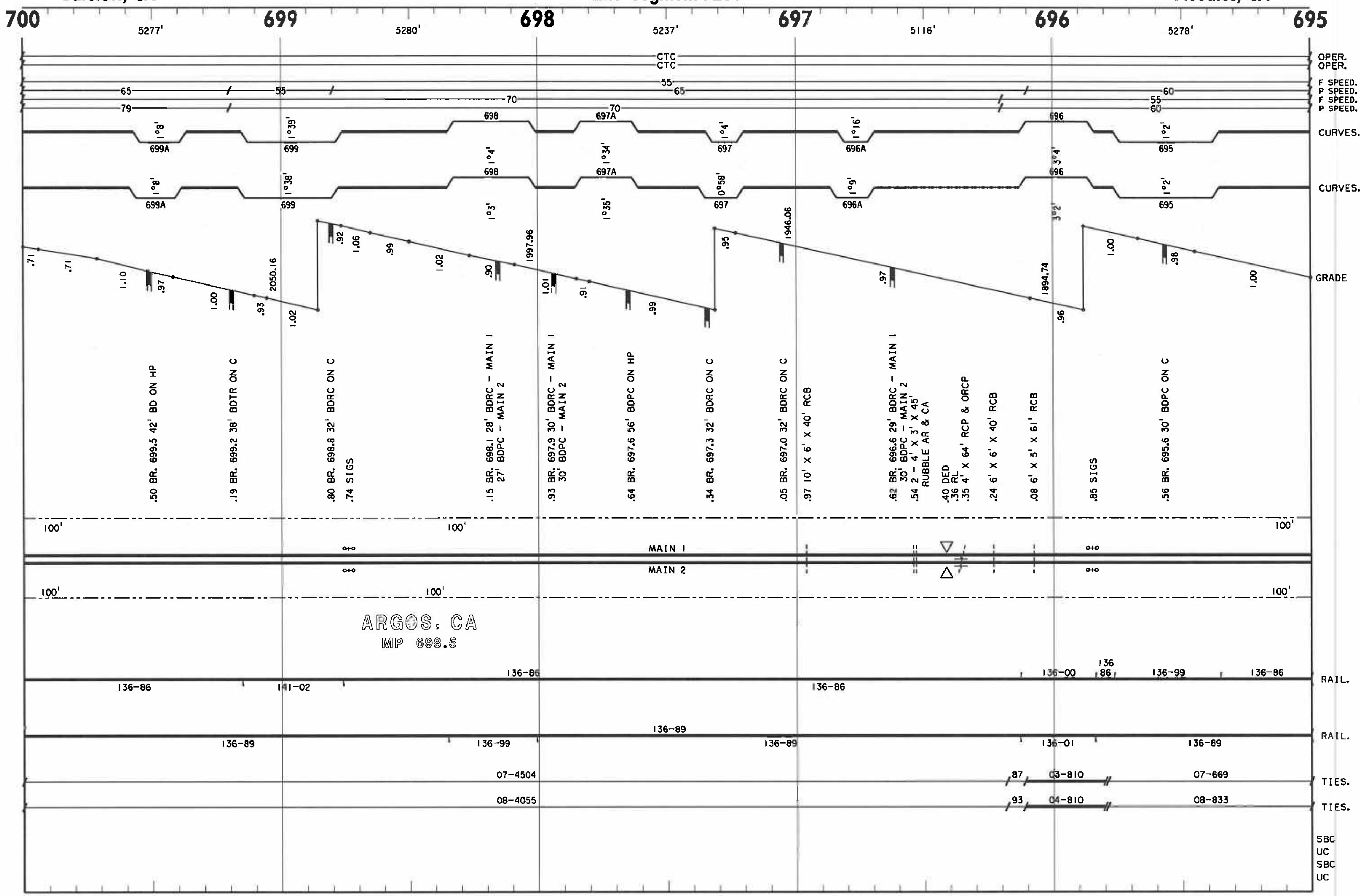
← Barstow, CA — Line Segment 7200 — Needles, CA →





9
Barstow, CA
Line Segment 7200
Needles, CA
710
709
708
707
706
705
5285'
5267'
5277'
5280'
5281'
OPER.
OPER.
CTC
CTC
F SPEED.
P SPEED.
F SPEED.
P SPEED.
CURVES.
CURVES.
GRADE
RAIL.
RAIL.
TIES.
TIES.
SBC
UC
SBC
UC
.53 BR. 709.5 20' BDTR ON C
.40 BR. 709.4 70' BD ON HP
.31 BR. 709.3 20' BDTR ON C
.23 SIGS
.20 DED
.71 BR. 708.7 16' BDPC BM
.50 BR. 708.5 42' BD ON HP
.26 PVT GR XING, 026041E
.84 RL
.75 NO. 10 T.O.
.68 BR. 707.7 29' BDTR ON C
.38 WT
.36 CANT SIG
.26 NO. 24 T.O.
.17 NO. 24 T.O.
.11 BR. 707.11 ST BMS ON C
PUB OP XING, 026039D
I 40 HWY
.04 CANT SIG
.78 BR. 706.8 14' BDRC - MAIN 1,
14' BDPC - MAIN 2
.60 NO. 14 T.O.
.82 NO. 14 T.O.
.28 NO. 11 T.O.
.26 BR. 705.3 14' BDPC
.26 CANT SIG
.25 NO. 24 T.O.
.17 NO. 24 T.O.
.13 SIGS
.11 PUB GR XING, F/G, 026038W
TAMARISK TREES
MAIN 1
MAIN 2
NATIONAL TRAILS HWY
WEST PISGAH
MP 707.3
PISGAH, CA
MP 706.6
EAST PISGAH
MP 705.2
train speed
hot box
crossing
signals
BNSF Railway Company
VS = AT CA-31
NEE009.DGN
Revised: 07/13/2009
Needles Subdivision


705
704
703
702
701
700
5280'
5280'
5288'
5270'
5279'
OPER.
OPER.
CTC
CTC
F SPEED.
P SPEED.
F SPEED.
P SPEED.
70
79
70
79
55
55
55
60
65
70
65
70
79
CURVES.
CURVES.
GRADE
1°1'
704
1°0'
704
0°29'
702A
0°29'
702A
702
3°1'
702
3°1'
1°2' 2°4'
700
1°1' 2°1'
700
.40
.50
.00
2151.15
.56
2162.17
.00
2165.15
.70
.75
2147.92
.75
2154.66
.93
.72
.20
.17
2180.03
2180.47
.93
.96
.89
.88
.19
.61
2141.43
.68
.74
.86
.94
.71
.92 BR. 704.9 28' BDPC HP
.64 BR. 704.6 15' BDRC – MAIN 1
14' BDTR – MAIN 2
.49 BR. 704.5 15' BDRC MAIN 1
14' BDTR – MAIN 2
.17 BR. 704.2 15' BDRC – MAIN 1
14' BDTR – MAIN 2
.92 BR. 703.9 15' BDRC – MAIN 1
14' BDTR – MAIN 2
.80 BR. 703.8 14' BDRC – MAIN 1
14' BDTR – MAIN 2
.64 2 – 42" X 45' ORCP
.22 BR. 703.2 30' BDPC ON C
.04 2 – 3' X 40' ORCP
.77 SIGS
.70 DED
200'
.42 36" X 42' ORCP
.34 42" X 49' ORCP
.21 30" X 40' ORCP
.16 RL
.96 42" X 48' ORCP
.45 BR. 701.4 28' BDPC ON C
.90 SIGS
.84 BR. 700.8 29' BDRC – MAIN 1
29' BDPC – MAIN 2
.53 2 – 3' X 41' ORCP
.15 2 – 4' X 44' RCP & ORCP
.04 RL
100'
100'
100'
100'
MAIN 1
MAIN 2
LAVIC, CA
MP 702.7
RAIL.
136-86
136-86
136-99
136-01
136-80
136-86
136-86
136-80
136-80
136-86
136-86
RAIL.
136-73
136-02
136-73
136-73
136-89
136-02
136-89
136-89
TIES.
07-5738
03
07-4504
TIES.
08-4273
04
08-4055
SBC
UC
SBC
UC


700
699
698
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696
695
5277'
5280'
5237'
5116'
5278'
CTC
OPER.
OPER.
F SPEED.
P SPEED.
F SPEED.
P SPEED.
CURVES.
CURVES.
GRADE
RAIL.
RAIL.
TIES.
TIES.
SBC
UC
SBC
UC
MAIN 1
MAIN 2
ARGOS, CA
MP 698.5
2050.16
1997.96
1946.06
1894.74
.50 BR. 699.5 42' BD ON HP
.19 BR. 699.2 38' BDTR ON C
.80 BR. 698.8 32' BDRC ON C
.74 SIGS
.15 BR. 698.1 28' BDRC – MAIN 1
27' BDPC – MAIN 2
.93 BR. 697.9 30' BDRC – MAIN 1
30' BDPC – MAIN 2
.64 BR. 697.6 56' BDPC ON HP
.34 BR. 697.3 32' BDRC ON C
.05 BR. 697.0 32' BDRC ON C
.97 10' X 6' X 40' RCB
.62 BR. 696.6 29' BDRC – MAIN 1
30' BDPC – MAIN 2
.54 2 – 4' X 3' X 45'
RUBBLE AR & CA
.40 DED
.36 RL
.35 4' X 64' RCP & ORCP
.24 6' X 6' X 40' RCB
.08 6' X 5' X 61' RCB
.85 SIGS
.56 BR. 695.6 30' BDPC ON C
136-86
141-02
136-89
136-99
136-00
136-01
07-4504
08-4055
03-810
04-810
07-669
08-833

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION

For the CALICO SOLAR (Formerly SES Solar One)

Docket No. 08-AFC-13

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(Revised 8/9/10)

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DECLARATION OF SERVICE

I, Harriet Vletas, declare that on August 17, 2010, I served and filed copies of the attached Prepared Direct Testimony of Dennis Skeels, BNSF Railway Company dated August 17, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:
[www.energy.ca.govlsitingcaseslsolarone].

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

_x__ sent electronically to all email addresses on the Proof of Service list;

___ by personal delivery;

___ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

_x__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

___ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 08-AFC-13
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

[signature]
HARRIET VLETAS

*indicates change

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Exhibit C

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of: The Application for Certification for the Calico Solar Power Project Licensing Case	Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF DAVID A. KRAUSS, Ph.D.
Senior Managing Scientist, Exponent

and

GENEVIEVE M. HECKMAN, Ph.D.
Senior Scientist, Exponent

August 16, 2010

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Anne Alexander
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anne.alexander@kattenlaw.com

Attorneys for Intervenor
BNSF Railway Company

Exhibit 1205

PREPARED DIRECT TESTIMONY

OF

David A. Krauss, Ph.D.

Senior Managing Scientist, Exponent

and

Genevieve M. Heckman

Senior Scientist, Exponent

Q.1 Please state your name and occupation?

A.1 Our names are David A. Krauss, Ph.D. and Genevieve M. Heckman, Ph.D. Dr. Krauss is a Senior Managing Scientist with Exponent; Dr. Heckman is a Senior Scientist with Exponent. Exponent is a multidisciplinary organization of scientists, physicians, engineers, and regulatory consultants that performs in-depth investigations in more than 90 technical disciplines. Exponent evaluates complex human health and environmental issues, assesses risks related to exposure to certain environmental conditions, and analyzes failures and accidents to determine their causes and to understand how to prevent them. We also evaluate complex human health and environmental issues to find cost-effective solutions.

Q.2 What is your particular area of expertise?

A.2 We have both obtained Ph.D.'s in neuroscience and have specialized knowledge in human perception and cognition, reaction time, attention, the effects of lighting conditions on vision, and how stress affects behavior. We assess risk associated with and investigate human factors in a wide array of scenarios. A copy of our respective *curriculum vitae* are attached hereto as Exhibits "A" and "B."

Q.3 Have you the studied the impact of glare and glint in your area of expertise?

A.3 Yes. This is typically done to determine the impact, if any, that glare or glint may have on a particular environment or has had on an accident.

Q4 Is there a body of professional literature that discusses and analyzes the effect of glint and glare?

A.4 Yes. There is an extensive body of literature that deals with both the effects of vehicle operators encountering bright lights during operation and the more physiological studies that deal with the changes to the retina when the retina is bombarded with bright light under various states of light adaptation.

Q.5. What have you been asked to do in relation to the Calico Solar Project?

A.5 We were asked to review and have reviewed the Staff Assessment and Supplemental Staff Assessment, Part II, on Traffic and Safety, as it relates to glare and glint, the associated study referenced in Appendix A, and to render an opinion as to the adequacy of the study and conclusions contained therein.

Q.6 After reviewing these materials, did you develop an understanding about the nature and purpose of the Calico Solar Project?

A.6 Yes, we did. As we understand it, this is relatively large solar energy project to be located in the Mojave Desert near Barstow. The proposed Project is to include 34,000 SunCatchers – 40 foot tall, 25-kilowatt-electrical (kWe) solar dishes developed by Stirling Energy Systems. [Supplemental Staff Assessment, Part II ("SSA Part II") at C.11-4];

Q.7 What is your opinion of the adequacy of the Supplemental Staff Assessment and associated study and the conclusions contained therein?

A.6 The Supplemental Staff Assessment, Part II, specifically makes a number of findings, three of which we focus on:

1. the SunCatchers could pose a significant risk to BNSF engineers and train crews, to include but not limited to temporary flash blindness, which would adversely impact the ability to see train signal lights [SSA Part II at C-11-19];

2. train signal lights are significant to the operational safety of the crews and trains [SSA Part II at C-11-19]; and

3. any escaping or itinerant glint and glare that may affect the railroad engineer's ability to clearly and accurately see signals is mitigable through shielding, LED lights, or other means designed to increase the contrast and intensity of the signal light [SSA Part II at C-11-19].

Q.8 What is your opinion of the adequacy of the first finding – the SunCatchers could pose a significant risk to BNSF engineers and train crews, to include but not limited to temporary flash blindness, which would adversely impact the ability to see train signal lights?

A.8 There is sufficient material in the SSA Part II, in particular the study attached as Appendix A ("Daytime Intrusive Brightness Analysis of Stirling Engine Solar Systems, by James Jewell, et al., (hereafter the "Jewell Report") that supports this finding. Although requested, we have not seen and there is not adequate time to review the underlying data associated with the Jewell Report. However, the Jewell Report states that the authors calculated the amount of light that is both captured by and escapes from a single SunCatcher. Based on their calculations, which at this point we assume to be accurate, they found that "significant glare impacts (temporary flash blindness) would occur to any receptor within 223 feet of any SunCatcher unit." [SSA Part II, Appendix A at A-8] Accordingly, the Jewell Report establishes that at least 223 feet must be maintained between any receptor and any SunCatcher. [See Jewell Report at SSA Part II, Appendix A at A-10 ("At any distance less than 223 feet from the SunCatcher units, construction and operational workers will experience hazardous levels of irradiance.").] The proposed Project, however, does not envision a single SunCatcher; it calls for 34, 000 SunCatchers. Moreover, the Jewell Report is a static evaluation – both the SunCatcher and the receptor are stationary. Here, we have a dynamic situation – we know the engineer will be in a moving train that is not traveling in a straight line. The Jewell Report does not analyze, calculate or measure the impact of thousands of SunCatchers specifically on a train engineer moving over tracks within the Right-of-Way (RoW). The adverse impact, therefore, may be greater than that stated in the Jewell Report.

Q.9 What is your opinion of the adequacy of the second finding – train signal lights are significant to the operational safety of the crews and trains?

A.9 This finding is supported by the SSA and the Jewell Report. Moreover, we have spoken with several personnel from BNSF in order to gain a better perspective of the importance of train signals to BNSF and the actual operators. Based on our discussions, it is clear that being able clearly to see train signals from an appropriate distance given the train's speed (varying between approximately 60-75 mph) and to respond accordingly is critical to the safety of the train and its crew. At these speeds, and depending upon the grade, it is our understanding that it can take over a mile of track to stop a train.

Q.10 What is your opinion of the adequacy of the third finding – any escaping or itinerant glint and glare that may affect the railroad engineer's ability to clearly and accurately see signals is mitigable through shielding, LED lights, or other means designed to increase the contrast and intensity of the signal light?

A.10 There is no scientific basis for this finding. No study has been performed that addresses these issues. According to the SSA, Part II at C.11-32, "Staff determined that measures exist, if needed, to ensure that BNSF railway engineers will be able to correctly perceive the color of the signal. Those procedures involves hooding and increasing the intensity of the lights." There is no analysis or data that supports this finding. The Jewell Report makes no mention of shielding, LED lights or other measures to increase the contrast and intensity of signal lights. While various mitigation measures may be helpful to reduce the impact of the glint and glare from the SunCatchers, to date no site-specific studies have been done to verify which measures, if any, would be able to mitigate the hazards identified in the above two findings. To reiterate, the Jewell Report is a static analysis of a single SunCatcher and a single receptor. Here, we have a dynamic situation and, to date, there has been no study or analysis to evaluate an engineer's ability to see a signal under such conditions.

Q.11 In your opinion, what needs to be done to properly assess the impact of glint and glare from the SunCatchers?

A.11 In addition to modeling the impact from a single SunCatcher, to fully evaluate this dynamic situation, the following factors, among others, need to be analyzed, measured and/or calculated:

1. The engineer's vantage point changes with respect to the location of SunCatchers in his visual field and the number of SunCatchers in his visual field as the engineer travels along the RoW;

2. The magnitude of glare may be affected by the geometry of the track, the changes in elevation, and the direction of travel;
3. The pattern of glare may have a differential effect on engineers depending on the time of day;
4. The pattern of glare may have a differential effect on engineers depending on the time of year;
5. There also may exist a level of glare that engineers may experience as a result of the SunCatchers that does not rise to a level that would induce the temporary flash blindness measured by the Jewell Report, but nonetheless causes discomfort that makes it difficult to focus in the direction of the SunCatchers;
6. While mitigation measures, including high contrast LED lights or black shielding, were suggested to enhance the conspicuity of railroad signals, the ability for engineers to perceive these signals out of a potentially bright, dynamically changing background has not been assessed to understand any possible discomfort or delays in detection that might arise out of the signal being viewed against a field of SunCatchers;
7. The perceived glint (high-contrast flicker) in the engineers' peripheral visual field may cause engineers involuntarily to orient their eyes and attention away from where they would otherwise be focusing their vision;
8. The size of the SunCatchers (up to 40 feet tall) may cause visual obstructions, independent of glare, that prevent engineers from perceiving job-critical information;

9. Light reflecting off the SunCatchers may result in a phenomenon known as a "phantom signal" whereby unlit signals appear to be illuminated because of abundant light striking them at low angles;
10. Since the trains are moving through the RoW, the distance traveled during expected look-away times as a result of the SunCatchers' presence should be calculated and the consequences of such travel should be assessed;
11. The effects of viewing multiple, indeed thousands, of SunCatchers simultaneously, rather than just one, must be analyzed to understand any cumulative glare effects that may arise;
12. The effects of viewing multiple SunCatchers simultaneously, for the entire period of time that the engineer is passing through the RoW, must be analyzed to understand any cumulative glare effects that may arise over time.

Q.12 The SSA Part II refers to "temporary flash blindness," (see, e.g., SSA Part II at C.11-19). Is this the only condition that could impair a train engineer's ability to see a signal and react in a timely manner?

A.12 No. In addition to temporary flash blindness, the Jewell Report refers to veiling reflections and/or distracting glare. [See SSA Part II, Appendix A at A-7.] Again, while the Jewell Report appears to account for temporary flash blindness from a single SunCatcher with a single receptor at a fixed point, it does not measure or otherwise account for the situation we have here, which involves multiple SunCatchers (i.e., thousands) at different elevations and different angles in a dynamic, moving scenario. This needs to be fully analyzed before one can render an opinion as to whether or not the 223-foot setback necessary for a single SunCatcher is sufficient for multiple SunCatchers.

Moreover, veiling effects and/or distracting glare are clearly noted in the Jewell Report as phenomena that are expected to occur as a result of light emitted from the SunCatcher. As the Jewell Report notes, it is well known that veiling reflections and/or distracting glare impact receptors "[b]eyond the distance that may cause temporary flash blindness [i.e., beyond 223 feet] and "may cause nuisance distraction or veil other objects (e.g., signal indicators for train operators) in the visual field." [SSA Part II, Appendix A at A-7.] In short, even with a single SunCatcher, the veiling reflection and/or distracting glare from the single SunCatcher may cause a disturbance in the train engineer's visual field such that the engineer cannot see the signal. The SSA Part II does not even mention these phenomena or otherwise attempt to account for them. The Jewell Report recognizes these phenomena but has done nothing to measure or quantify their impact. Moreover, as with temporary flash blindness, the Jewell report fails to account for, analyze, or measure the cumulative effect of thousands of SunCatchers on veiling reflections and/or distracting glare at different heights and angles in a dynamic, moving scenario.

Q.13 Have you reviewed TRANS-7 in the SSA Part II and do you have an opinion regarding whether it will adequately address the significant safety issues regarding the impact of glint and glare on train operators?

A.13 Yes. There is a discussion of TRANS-7 at C.11-19 and the actual proposed Condition of Certification is set forth at C.11-36-39 and is divided into two parts, "Signal Light Modifications," and "General Location, Operating, and Reporting Procedures." During the discussion on C.11-19, Staff notes that glare and glint is "mitigable" and that TRANS-7 is "designed to reduce to less than significant the operational impacts of the SunCatchers … to BNSF Railway and AMTRAK crews and passengers." The scientific analysis performed in the Jewell Report is insufficient to support this conclusion or the separate or collective potential, and as yet untested, mitigation measures suggested therein. For example, the Signal Light Modifications section assumes without any analysis or study that signals can be modified by affixing shields and/or utilizing what is referred to as "current LED signal technology." Without more information there is simply no basis for this assumption. The Jewell Report itself has no such reference to signal light modification, shielding, or "current LED signal technology." The General Location, Operating, and Reporting Procedures section sets forth numerous requirements regarding offset tracking procedures and stow positions. While there is reference to offset tracking and stow positions in the Jewell Report (e.g., the reference to modifying offset tracking from 10 degrees to 25 degrees [SSA Part II, Appendix A-11]), there is no accompanying calculation to establish the sufficiency of this proposed offset. Additionally, the Jewell Report is based on a single SunCatcher and a single receptor; it does not take into account the dynamic situation here. With thousands of SunCatchers at different elevations and a train moving along a curved track for several miles, the view of the engineer and the angle between the engineer and the respective SunCatchers will change constantly. This has not been quantified or otherwise taken into account. Not until the full effects of the SunCatchers' field are studied and determined, is one able to propose, evaluate, and select potential mitigation measures.

Q.14 Did you prepare any demonstratives to illustrate some of these concepts?

A.14 Yes.

Q.15 Please explain how these relate to the present discussion.

A.15 Exhibits 1-2 demonstrate an important concept in visual search – that is, that the background against which a target (in this case, the upward tilted line) is viewed has a significant and measurable impact on the ease with which that target is located. Exhibit 3 illustrates the "phantom signal" phenomenon, in which direct external illumination can hinder a driver or operator's ability to discern whether a signal light is illuminated. Finally, Exhibit 4 depicts a simple demonstration of the spatial summation of light.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: August 16, 2010

David A. Krauss, Ph.D.

Genevieve M. Heckman, Ph.D.

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David A. Krauss, Ph.D.
Senior Managing Scientist

Professional Profile

Dr. David A. Krauss is a Senior Managing Scientist in Exponent's Human Factors practice. Dr. Krauss has specialized knowledge in human perception and cognition, reaction time, attention, the effects of lighting conditions on vision, and how stress affects behavior. He uses this experience to investigate human factors in a wide array of scenarios such as automobile accidents, industrial and occupational accidents, structure fires, and slip-and-fall incidents. Dr. Krauss has investigated accidents associated with industrial safety, motor vehicles, and consumer products, among others.

Dr. Krauss' analysis methods include programming custom image-processing software to quantify visibility and conspicuity for many applications, including product development and recreating accident scenarios. He has also developed, published, and implemented a method to accurately capture and display digital photographs of low-visibility or nighttime accident scenes. Additionally, he performs quantitative injury and risk analyses using large-scale incident and injury data from various sources including the Consumer Product Safety Commission (CPSC), Centers for Disease Control (CDC), Food and Drug Administration (FDA), and manufacturer trade associations.

As part of his consulting practice, Dr. Krauss oversees human-subject testing to assess product usability and to gather user opinions for various products. He incorporates elements of anthropometry, visual assessments, psychophysics, questionnaires, and observational techniques to conduct comprehensive evaluations of a variety of consumer and industrial products.

Dr. Krauss' doctoral dissertation addressed human visual perception and reading. His familiarity with the cognitive-psychology literature has been applied to the development of warnings, instructions, and safety information for various products as well as to the assessment of the role of warnings in accidents.

Academic Credentials and Professional Honors

Ph.D., Psychology/Cognitive Neuroscience, University of California, Los Angeles, 2003
M.A., Psychology/Cognitive Neuroscience, University of California, Los Angeles, 2000
B.S., Biopsychology and Cognitive Science, University of Michigan, 1998

Pauley Graduate Fellowship, University of California, Los Angeles (1998)
Undergraduate honors, University of Michigan (1994)

Licenses and Certifications

OSHA-Qualified General Industry Safety Trainer; Certified Forklift Operator

Exhibit A Krauss-Heckman

Publications

Khan F, Arndt S, Krauss D. Understanding the relationship between safety climate and warning compliance in occupational settings. Proceedings, 14th Annual International Conference on Industrial Engineering: Theory, Applications and Practice, Anaheim, CA, 2009.

Polk TA, Lacey HP, Nelson JK, Demiralp E, Newman LI, Krauss D, Raheja A, Farah MJ. The development of abstract letter representations for reading: Evidence for the role of context. Cognitive Neuropsychology 2009; 26(1):70–90.

Kubose T, Krauss D. Methodological considerations for using the English XL tribometer for post-hoc slip-and-fall evaluations. Proceedings, 52nd Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA, 2008.

Krauss D, Arndt S, Lakhiani S, Khan F. Additional considerations when applying the "Safety Engineering Hierarchy" in industrial work settings. Proceedings, 13th Annual International Conference on Industrial Engineering: Theory, Applications and Practice, Las Vegas, NV, 2008.

Arndt S, Krauss D, Weaver B. A previously unidentified failure mode for ladder-climbing fall-protection systems. Proceedings, American Society of Safety Engineers Professional Development Conference and Exposition, Las Vegas, NV, 2008.

Arndt S, Young D, Krauss D. Human factors issues in trucking—What does a qualified expert need to know? Trucking Law Seminar, Phoenix, AZ, April 17, 2008.

Krauss D, Lieberman D, Grossman H, Ray R, Scher I. An evaluation of perceptual experience of skiers using quantitative image processing. Journal of ASTM International 2008; 5(4).

Kuzel M, Krauss D, Moralde M, Kubose T. Comparison of subjective ratings of slipperiness to the measured slip resistance of real-world walking surfaces. International Conference on Slips, Trips and Falls, From Research to Practice, 2007.

Krauss DA, Kuzel MJ, Cassidy P, Goodman J. A review of technologies for studying visual perception under low-illumination conditions. Proceedings, 50th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA, 2006.

Arndt SR, Wood CT, Delahunt PB, Wall CT, Krauss DA. Who's in the back seat? A study of driver inattention. Proceedings, 50th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA, 2006.

Krauss DA, Kuzel MJ, Arndt SR, Delahunt PB. Validation of digital image representations of low-illumination scenes. SAE Paper 2006-01-1288, Society for Automotive Engineers, Inc., 2006.

Young D, Huntley-Fenner G, Trachtman D, Krauss D. Human performance issues in auditory collision-avoidance systems. Proceedings, 10th Annual International Conference on Industrial Engineering—Theory, Applications and Practice, pp. 64–68, Clearwater, FL, 2005.

Al-Tarawneh IS, Cohen WJ, Trachtman D, Bishu RR, Krauss DA. The effect of hands-free cellular telephone conversation complexity on choice response time in a detection task. Proceedings, 48th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA, 2004.

Krauss DA. Mechanisms of letter perception. Doctoral Dissertation, Department of Psychology, University of California, Los Angeles, June 2003.

Presentations and Posters

Clausner TC, Fox JR, Krauss DA. Comprehension and production of graphs that metaphorically express linguistic semantic event structure. 8th International Cognitive Linguistics Conference, La Rioja, Spain, 2003.

Krauss DA, Engel SA. Effects of stimulus crowding in human extrastriate cortex. Meeting of the Society for Neuroscience, San Diego, CA, 2001.

Krauss DA, Engel SA. Differential effects of crowding on feature detection and letter recognition. Meeting of the Cognitive Neuroscience Society, New York, NY, 2001.

Krauss DA, Engel SA. Perceptual learning in color classification. Meeting of the Association for Research in Vision and Ophthalmology, Fort Lauderdale, FL, 2000.

Polk TA, Krauss D, Nelson J, Pond H, Raheja A, Farah MJ. The development of abstract letter identities: Evidence for a contextual hypothesis. Annual Meeting of the Psychonomics Society, 1998.

Project Experience

Evaluated the visibility of pedestrians, tractor-trailer combinations, and other parked vehicles on roadways under various reduced-lighting conditions.

Analyzed the performance capabilities, including perception-response time, for drivers and pedestrians under a variety of lighting and traffic conditions.

Created representative low-light photographs to use as demonstrative exhibits using recently developed and validated software and photography techniques.

Used the English XL tribometer to evaluate slip resistance on various flooring surfaces and correlated these measurements with pedestrian expectations of surface traction.

Programmed custom software in Matlab® to assess the visibility of terrain on a ski mountain under a variety of lighting conditions. These measurements were correlated with skier and snowboarder subjective ratings to understand perceptual biases to aid in predicting potentially hazardous visibility conditions.

Assisted companies with development and revision of product warnings and instructions for a wide range of products including those used in home, occupational, recreational, and agricultural settings.

Academic Appointments

- Lecturer, University of California, Los Angeles Department of Psychology
- Instructor, University of California, Los Angeles Extension

Peer Reviewer

- Human Factors and Ergonomics Society
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Professional Affiliations

- Human Factors and Ergonomics Society (member)
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Professional Profile

Dr. Genevieve Heckman is a Senior Scientist in Exponent's Human Factors practice. Dr. Heckman has specialized expertise in human perception and cognition, reaction time, and decision-making, as well as lighting and illumination, inattention and distraction, and the effects of training and experience on performance. Dr. Heckman uses her knowledge of fundamental human sensory and cognitive processes to evaluate human factors and human performance issues in a wide variety of scenarios including trips, slips, and falls; motor vehicle and pedestrian accidents; occupational and industrial accidents; on-product warnings and safety information; child safety and hazards; and the use and misuse of consumer products. She has experience conducting visibility and conspicuity analyses; evaluating optical radiation hazards in industrial settings; and assessing the factors influencing driver and pedestrian behavior, reaction time, performance in sports and recreation, and compliance with warnings and instructions. In her work, Dr. Heckman uses a variety of analysis methods, including human subjects testing, quantitative injury and risk analyses, and use of image-processing techniques to quantify visibility, conspicuity, and discriminability under diverse viewing conditions.

Prior to joining Exponent, Dr. Heckman completed a Ph.D. in psychology, with specialization in cognitive neuroscience, at the University of California, Los Angeles. Her work during that time used a combination of behavioral, neuroimaging, and mathematical techniques to study human perception of color and lighting, the effects of experience on perceptual capabilities, and optimal experimental design in fMRI experiments. Her graduate work was supported by awards from the University of California, the National Institutes of Health, and the National Science Foundation.

Academic Credentials and Professional Honors

Ph.D., Psychology/Cognitive Neuroscience, University of California, Los Angeles, 2007
M.A., Psychology/Cognitive Neuroscience, University of California, Los Angeles, 2004
B.A., Psychology, Wake Forest University, 2002

Hobson Dissertation Year Fellow, University of California, Los Angeles, 2006; National Science Foundation Graduate Research Fellow, University of California, Los Angeles, 2003–2006; Phi Beta Kappa Honor Society, Wake Forest University, 2002

Exhibit B Krauss-Heckman

Publications

Heckman GM, Jackson GW, Keefer RE, Ray R, Harley EM, Young DE. Mechanisms of automatic transmission console shift selection and driver egress. Society of Automotive Engineers 2009 World Congress, April 2009. Paper judged to be among the most outstanding SAE Technical Papers of 2009 and thus further published in the SAE International Journal of Engines, Volume 2, September 15, 2009.

Harley EM, Trachtman D, Heckman GM, Young DE. Driver gear-shifting behaviors and errors. Proceedings, Human Factors and Ergonomics Society, 52nd Annual Meeting, New York, NY, 2008.

Heckman GM, Bouvier SE, Carr VA, Harley EM, Cardinal KS, Engel SA. Nonlinearities in rapid event-related fMRI explained by stimulus scaling. Neuroimage 2007; 34:651–660.

Heckman GM, Muday JA, Schirillo JA. Chromatic shadow compatibility and cone-excitation ratios. Journal of the Optical Society of America A 2005; 22:401–415.

Presentations and Published Abstracts

Heckman GM. Mechanisms of learning in a color detection task. Invited talk given at the Smith-Kettlewell Eye Research Institute Colloquim Series, San Francisco, CA, November 2006.

Heckman GM, Engel SA. Perceptual learning of contrast detection is color selective. Poster session presented at the annual meeting of the Vision Sciences Society, Sarasota, FL, May 2006.

Harley EM, Bouvier SE, Heckman GM, Engel SA. Figure-ground effects in V1 measured with functional MRI. Poster session presented at the annual meeting of the Vision Sciences Society, Sarasota, FL, May 2006.

Heckman GM, Cardinal KS, Harley EM, Bouvier SE, Carr VA, Engel SA. Characterizing contrast response functions measured with rapid event-related fMRI. Poster session presented at the annual meeting of the Vision Sciences Society, Sarasota, FL, May 2005.

Cardinal KS, Harley EM, Heckman GM, Bouvier SE, Carr VA, Engel SA. Comparison of contrast response functions measured with rapid and spaced event-related fMRI. Poster session presented at the annual meeting of the Society for Neuroscience, San Diego, CA, October 2004.

Heckman GM, Engel SA. Spatial frequency modulates color selectivity of adaptation to contrast patterns. Poster session presented at the annual meeting of the Vision Sciences Society, Sarasota, FL, May 2003.

Schirillo JA, Heckman GM, Barra T. A chromatic test of shadow compatibility and equal cone excitation ratios. Poster session presented at the annual meeting for the Vision Sciences Society, Sarasota, FL, May 2003.

Peer Reviewer

- Human Factors and Ergonomics Society

Professional Affiliations

- Human Factors and Ergonomics Society
- Vision Sciences Society

Visual Search:
Find the upward tilted purple line

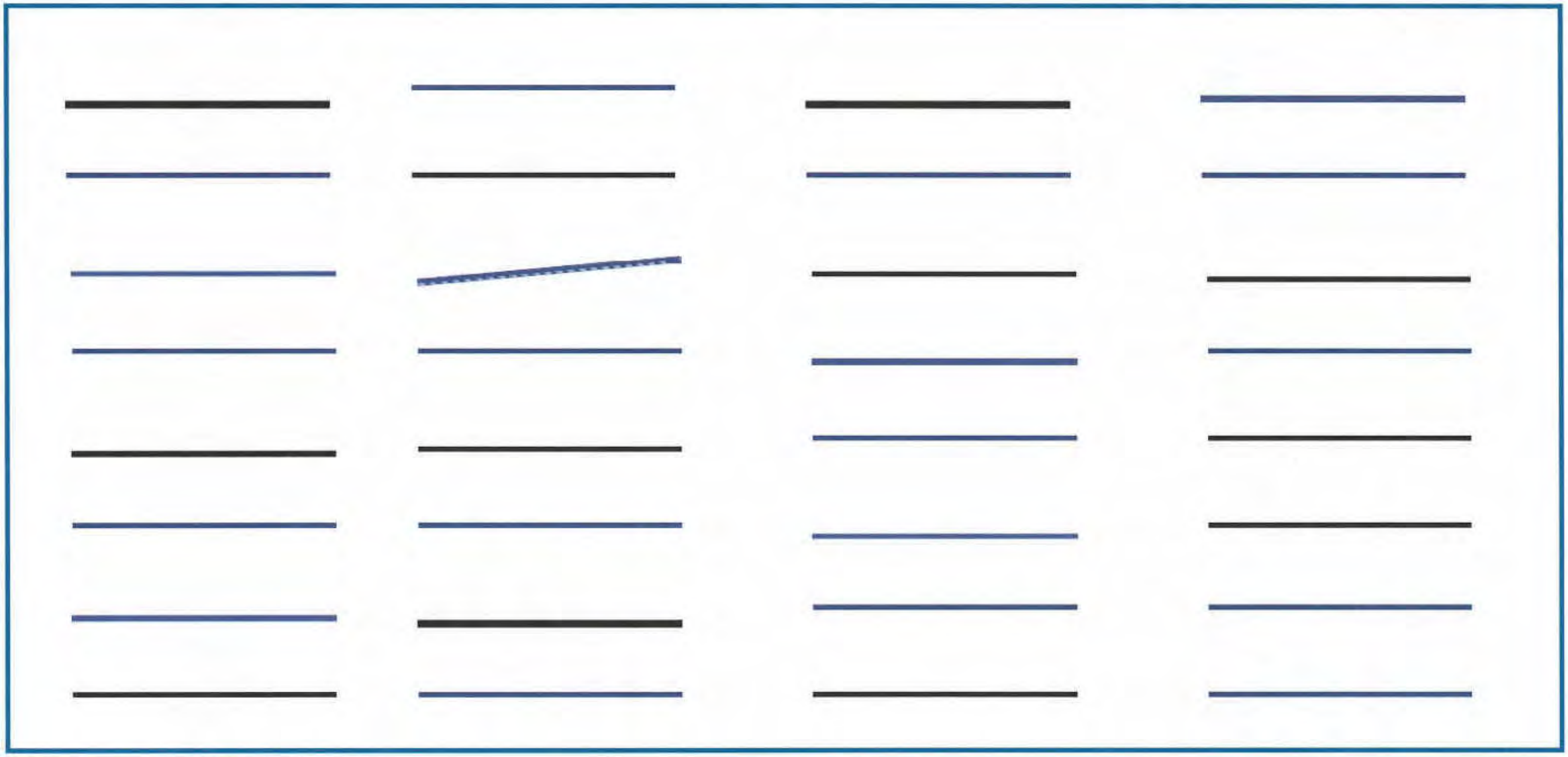


Exhibit 1 Krauss-Heckman

Visual Search:
Find the same upward tilted purple line

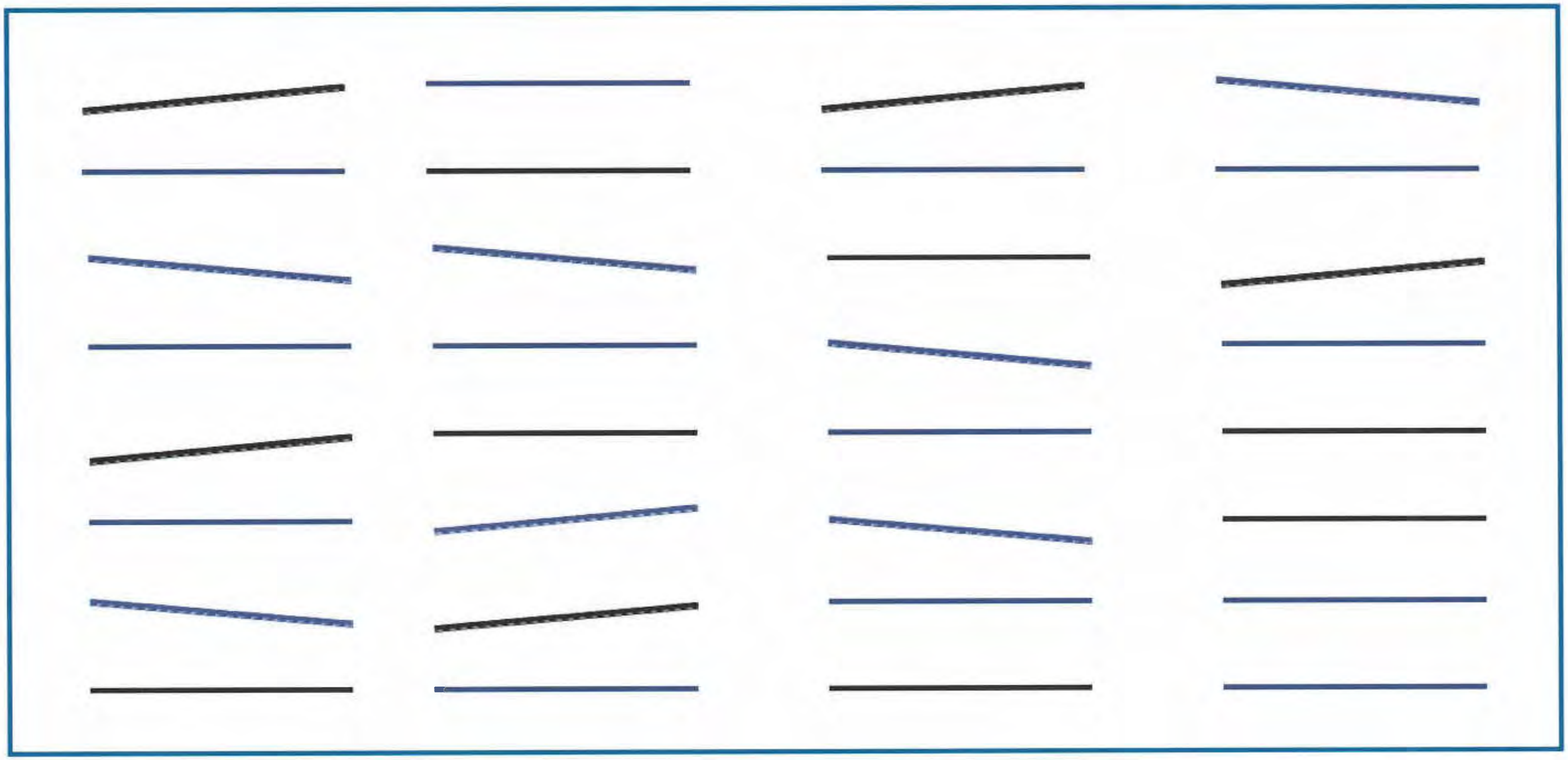


Exhibit 2 Krauss-Heckman

“Phantom Signals”

Excess of direct external illumination on a signal makes it difficult to discern which signal is illuminated.

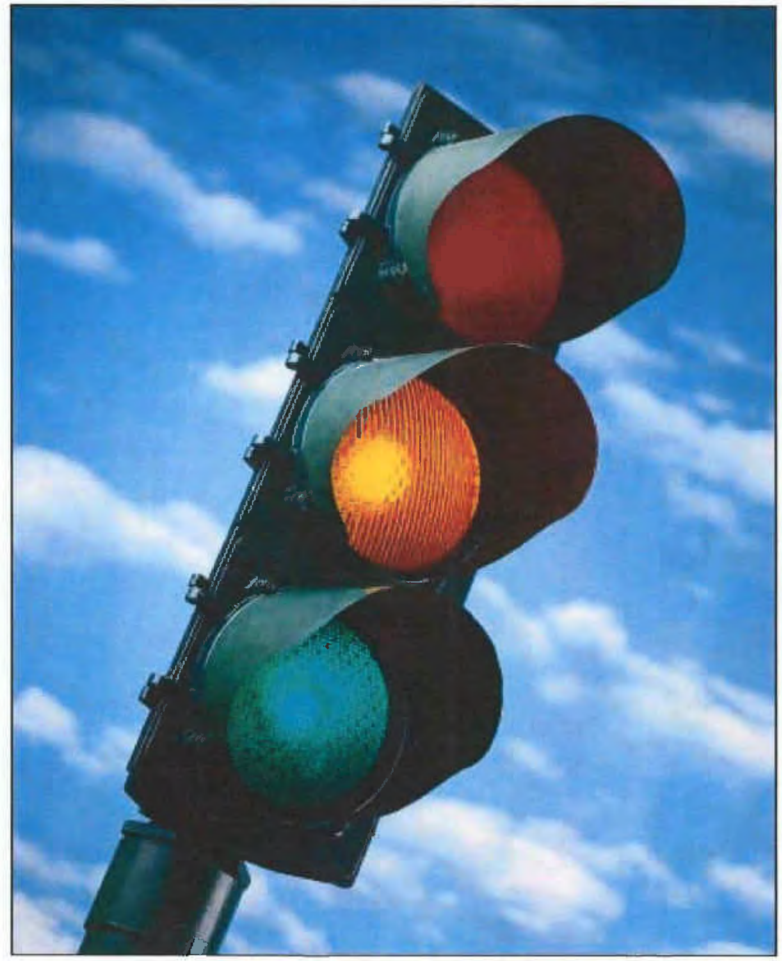
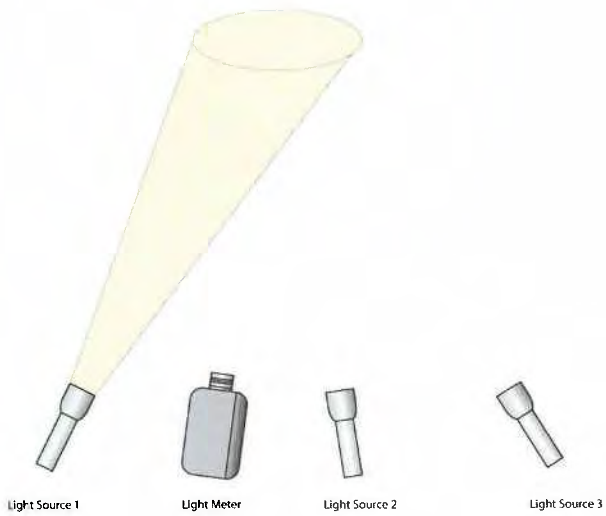
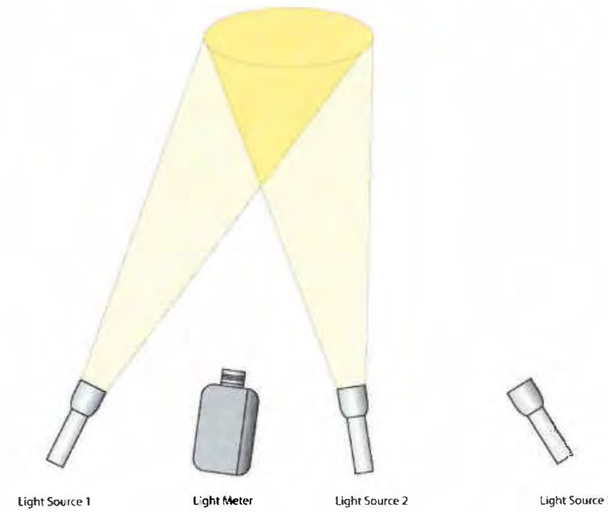


Exhibit 3 Krauss-Heckman

Spatial Summation of Light





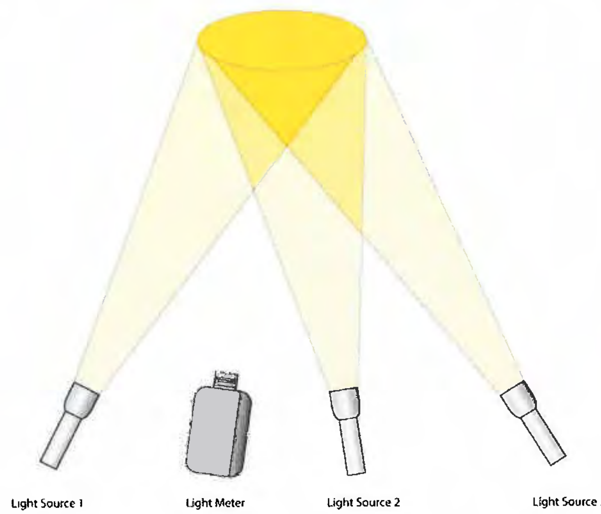


Exhibit 4 Krauss-Heckman

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION

For the CALICO SOLAR (Formerly SES Solar One)

Docket No. 08-AFC-13

PROOF OF SERVICE
(Revised 8/9/10)

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Declaration of Service

I, Harriet Vletas, declare that on August 17, 2010, I served and filed copies of the attached Prepared Direct Testimony of David A. Krauss, Ph.D and Genevieve M. Heckman, Ph.D. dated August 16, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:
[www.energy.ca.govlsitingcaseslsolarone].

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

For service to all other parties:

_x__ sent electronically to all email addresses on the Proof of Service list;

___ by personal delivery;

___ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

For filing with the Energy Commission:

_x__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

___ depositing in the mail an original and 12 paper copies, as follows:

California Energy Commission
Attn: Docket No. 08-AFC-13
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

Harriet Vletas
HARRIET VLETAS

*indicates change

31532494_2.DOC

Exhibit D

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of: The Application for Certification for the Calico Solar Power Project Licensing Case	Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF THOMAS SCHMIDT
BNSF RAILWAY COMPANY

July 29, 2010

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Attorneys for Intervenor
BNSF Railway Company

PREPARED DIRECT TESTIMONY

OF

Thomas Schmidt

Director Engineering Services – BNSF

Q.1 Please state your name and occupation?

A.1 My name is Thomas Schmidt. I am Director of Engineering Services, BNSF Railway Company ("BNSF"). My resume is attached to this testimony.

Q.2 What is the purpose of your testimony in this proceeding?

A.2 I will testify on two areas of concern to BNSF:

(1) soil and water resources (detention basins); and

(2) hydrology (subsidence).

Q.3 Why does BNSF have concerns regarding the Calico Solar Project?

A.3 BNSF is one of two Class 1 railroads operating in California. BNSF's mainline, which is traversed by as many as 80 trains per day, carries interstate commerce from the Ports of Los Angeles and Long Beach to U.S. Midwestern, Southwestern and Eastern markets. The proposed Project would surround both sides of several miles of BNSF's mainline tracks. Accordingly, BNSF has significant concerns that the construction and operation of the Project do not adversely impact BNSF operations or otherwise impose unacceptable safety risks to BNSF personnel and operations.

The consummation of the Project would require the granting of several licenses and permits from BNSF, which Applicant Calico Solar ("Calico Solar") has requested in a piecemeal fashion over the course of the past year. To date, none of these requested licenses or permits have been granted. Before BNSF can grant such licenses and permits, BNSF must be assured that its significant safety and operational concerns are addressed.

Q.4 What are BNSF's safety and operational concerns in relation to soil and water resources (detention basins)?

A.4 BNSF is concerned that detention basins in the present documentation are possibly not sufficient to protect the tracks and their supporting structures. The Project incorporates detention basins that have been designed for a 100 year flood. SSA. P. C.7-26. Given the gradient of the Project site, BNSF is concerned that the steps being proposed are not adequate to ensure protection of the tracks and their supporting structures or soil. A characteristic of high desert environs such as the Project site is an increased likelihood of flash floods, which over a sustained period of hours or days may cause the detention basins to overflow and cause a high volume of water in a concentrated flow to wash through the area, eroding the terrain around and supporting the tracks. As the former roadmaster for territory adjacent to this portion of the mainline, I have personal experience with sudden flash floods in the desert.

Q.5 Are you aware of any site specific studies that address the potential impact to the rail if there is a sudden and catastrophic rupture or overtopping of one or more of the detention basins?

A.5 No. It needs to be determined whether Calico Solar should be required to fund the reinforcement of rail infrastructure.

Q.6 What are BNSF's safety and operational concerns in relation to hydrology (subsidence)?

A.6 BNSF understands that, under the current application, Calico Solar intends to draw water from a water well on the Project site. BNSF is concerned the potential drawdown of the groundwater basin by the newly proposed water well may cause subsidence which might adversely affect rail track alignment, increasing the risk of increased maintenance of a derailment. While the SA/DEIS briefly addresses the issue of possible subsidence due to groundwater pumping at p. C.4-12, and the SSA discusses the issue at C.4-13 (Geology and Paleontology), BNSF is concerned that the analysis may not be sufficient. In addition, while Calico Solar represents that it is currently the only water user in the groundwater basin, BNSF notes that it intends to preserve the option of replacing its abandoned wells in the Hector Road location.

BNSF understands that Calico Solar is required to conduct groundwater monitoring on a quarterly basis. BNSF requests that as a Condition of Certification, Calico Solar be required to provide BNSF with such quarterly reports, and that a notification procedure be put in place for any noted subsidence, whereby BNSF maintenance teams would be alerted of the issue.

Q.7 Does this complete your direct testimony?

A.7 Yes, it does.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: July 29, 2010

Thomas B Schmidt PE

Thomas Schmidt

Thomas Schmidt, P.E.

Curriculum Vitae

As Director Engineering Services – BNSF Railway Company, Mr. Schmidt is responsible for management of construction activities within the BNSF railway system from Chicago to Los Angeles. As part of his 34-year tenure with BNSF, Mr. Schmidt spent 14 years working in BNSF's track department handling the issues to which the railroad is exposed on a regular basis throughout the country arising from flooding and other natural disasters. During this time, Mr. Schmidt spent six months in Needles, California, where, among other things, he handled the specific flood and disaster issues which arise in a desert environment.

1990-current **BNSF Railway Engineering Department**

Director Engineering Services (1995-current)

- Responsible for management of new construction and expansion of facilities and physical plants pertinent to railroads, including mainlines, sidings and intermodal facilities.
- Assist track department with maintenance of track and roadbed.
- Responsible for permitting, mitigation, and reconstruction both for new development and in response to catastrophic events, as needed.

Construction Engineer (1990-1995)

1976-1990 **BNSF Railway Track Department**

Assistant Division Engineer (1982-1990)

Roadmaster (1980-1982)

Assitant Roadmaster, Management Trainee (1976-1980)

Education

B.S. Civil Engineering University of Kansas 1975
Licensed Professional Engineer licensed in State of Kansas

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION
For the CALICO SOLAR (Formerly SES Solar One)

Docket No. 08-AFC-13

PROOF OF SERVICE
(Revised 7/12/10)

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Declaration of Service

I, Harriet Vletas, declare that on July 30, 2010, I served and filed copies of the attached Prepared Direct Testimony of Thomas Schmidt, dated July 29, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[www.energy.ca.govlsitingcaseslsolarone]**.

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

For service to all other parties:

_x__ sent electronically to all email addresses on the Proof of Service list;

___ by personal delivery;

___ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

For filing with the Energy Commission:

_x__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

___ depositing in the mail an original and 12 paper copies, as follows:

California Energy Commission
Attn: Docket No. 08-AFC-13
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

[signature]
HARRIET VLETAS

*indicates change

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Exhibit E

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of:
The Application for Certification for the Calico Solar Power Project Licensing Case

Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF DAVID MILLER
Manager Engineering, BNSF Railway Company

September 17, 2010

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Attorneys for Intervenor
BNSF Railway Company

PREPARED DIRECT TESTIMONY

OF

David Miller

Manager Engineering, BNSF Railway Company

Q.1 Please state your name and occupation?

A.1 My name is David Miller. I am Manager Engineering with BNSF Railway Company ("BNSF"). I have been with BNSF for twenty-eight years and I have an engineering degree.

Q.2 What is your particular area of expertise?

A.2 I oversee construction for BNSF throughout southeastern California and all of New Mexico and Arizona. I am called upon to respond to emergency situations for the railroad. For example, I am called upon to respond to situations where high water erodes track embankment or bridges.

Q.3 What is the purpose of your testimony?

A.3 To outline the concerns that BNSF has regarding the current two alternatives being proposed by Applicant, Alternative 5.5 and 6, which completely eliminate the debris basins and detention basins that were critical safety features and mitigation measures of the proposed project for many months.

Q.4 Why did BNSF not question Calico Solar's hydrology witnesses at the hearings in August?

A.4 BNSF relied on Calico Solar's statements at the hearing in August and Calico Solar's stipulation that it agreed to put detention basins in the project, fund additional studies, and fully mitigate the anticipated flood hazards associated with its project.

Q.5 In your opinion, given the recent change in alternatives, which delete the debris and retention basins, the current lack of a hydrological study to support the new alternatives, and new issues raised by Calico Solar, does BNSF have sufficient information to analyze and grant Calico Solar's four requests for licenses and crossings on the BNSF ROW?

A.5 No. As of last Friday, September 10, 2010 it was BNSF's understanding Calico Solar was going to again redesign its proposed facility and present an alternative 5.5 and an alternative 6. We received conceptual designs of those 2 alternatives on Friday night. On Monday we received additional reports and declarations by a number of Calico Solar's experts. The alternatives and the expert reports and declarations delete debris and retention basins, provide analyses and conclusions that contradict previous reports, declarations and testimony before the CEC and contain significant changes from what was BNSF's understanding of the potential hydrological impact of the proposed project on the BNSF ROW.

Understandably, our experts have only begun to analyze the new situation. Among Calico Solar's Monday declarations is one by Matt Moore of URS which states "Existing sedimentation and maintenance issues at railroad facilities represent an existing condition that would not be significantly altered by Scenario 5.5 or 6." BNSF does not know what this statement is referring to and will need to know the basis for this statement before it can proceed further with the Applicant's requests of BNSF. If Calico Solar has any concerns with the BNSF ROW, BNSF needs to know what they are at this time as Calico

Solar is requesting: (1) BNSF allow it to drive hundreds of trucks and cars over the ROW; (2) BNSF build a new temporary at-grade crossing for Calico Solar's use in the ROW; (3) BNSF allow it to build a bridge over the BNSF ROW; and (4) BNSF allow an expansion of an at-grade crossing's use to allow for emergency access to the Calico Solar site. BNSF must be advised of and allowed time to evaluate any concerns Calico Solar may have before BNSF can determine if such uses and infrastructure are compatible with railroad infrastructure and operations and where they might best be located. BNSF has asked for a precise location of all SunCatchers and related infrastructure so we can assess potential impacts on the ROW that need to be considered in processing Calico Solar's applications. These include hydrological impacts. To date BNSF has not been provided this information.

Because of the impact these changes may have on BNSF's analysis of the safety and protection of the ROW and whether Calico Solar's proposed uses are compatible with existing rail operations, BNSF has been delayed in processing Calico Solar's applications. There have been numerous changes to the Calico Solar project over the past year and the BNSF staff trying to process Calico Solar's applications has had to redirect its efforts several times. Given the 10 day old change in direction and the presentation of 2 alternatives, BNSF does not know which is the preferred alternative to analyze. Under these circumstances, BNSF is not able to process Calico Solar's four requests and is unable to grant the licenses, easements and crossings at this time.

Q.6 Is there a historical basis for BNSF's concerns relating to heavy rainfall and flooding in the area of the project site?

A.6 Yes. The BNSF Railway Company has experienced heavy rainfall events in this area with the water surface rising as high as the bridge girders. However, there is no record of historic floods overtopping the tracks. This historic flooding demonstrates that the current drainage system does not have additional capacity to spare and it is critical that the proposed Calico Solar development maintain historic flows. Any increases in flows or sediment to the railroad drainage could result in overtopping of the railroad tracks. Therefore the BNSF Railway Company requires more substantial analysis for the hydrology of the proposed development to demonstrate that the construction of 24,000 sun catcher, miles of maintenance roads, a 90 acre substation and the associated construction disturbance to the desert top soils will not change the existing drainage to the railroad structures.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: September 17, 2010

David Miller

Exhibit F

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of:
The Application for Certification for the Calico Solar Power Project Licensing Case

Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF STEVEN J. METRO, PE
Senior Civil Engineer, Wilson Company

September 14, 2010

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PREPARED DIRECT TESTIMONY

OF

Steven J. Metro, PE

Senior Civil Engineer, Wilson Company

Q.1 Please state your name and occupation?

A.1 My name is Steven J. Metro. I am a Senior Civil Engineer with Wilson Company. Wilson Company is a civil engineering and consulting company. Approximately one fourth of all of our work is for the railroads. The company has completed at least 30 drainage and flood studies for railroad bridges throughout the Southwest.

Q.2 What is your particular area of expertise?

A.2 I am a licensed professional engineer. I have particular experience in drainage and flooding issues and have worked on numerous matters involving the railroads. I have worked on over twenty matters involving drainage and flooding issues in a desert environment with alluvial fans. I have seen first hand the effects of flooding caused by structural improvements placed upgradient from a railroad right-of-way. In my practice, I routinely interface with Army Corps of Engineers and local flood control districts. I have provided expert testimony regarding flood damage to railroad infrastructure. A copy of my *curriculum vitae* is attached hereto as Exhibit "A."

Q.3 What is the purpose of your testimony?

A.3 To outline the concerns that BNSF has regarding the current two alternatives being proposed by Applicant, Alternative 5.5 and 6, which completely eliminate the debris basins and detention basins that were critical safety features and mitigation measures of the proposed project for many months. The Record in this matter clearly reflects that upon reviewed of the proposed project, Applicant experts acknowledged and Staff experts found that the proposed project would adversely impact the storm water runoff over and through the area encompassing the proposed project. This adverse impact is a result of the fact that the placement of over 24,000 SunCatchers, foundations and pads for the main service complex and substation, the hundreds of miles of access and service roads, and associated structures required to support the proposed project, which will necessarily decrease the surface area that will allow absorption of storm water and the day-to-day operations associated with the facility that will create new channels throughout the site. The impervious nature of these structures and facilities and the newly created channels will result in an increase flow of stormwater and will alter the already shifting and unpredictable nature of the streambeds within the alluvial fans in the proposed project area. In turn, this will have an adverse impact on the BNSF Right-of-Way that runs through the proposed project in that the BNSF Right-of-Way will necessarily encounter increased flows and sediment deposits along the Right-of-Way as a result of the proposed project. This will result in an increased risk of flooding and scour that the existing trestles and Right-of-Way grade may not be able to accommodate. Ultimately this could result in an increased potential to wash out portions of the BNSF Right-of-Way and portions of the transcontinental mainline track, interrupting a critical interstate transportation artery. To mitigate this significant safety risk and environmental hazard, both Applicant and the Staff proposed a network of debris basins on the northern boundary of the proposed project site, upgradient of the BNSF Right-of Way. These debris basins would be designed to capture some but not all of the storm water and associated debris from the Cady Mountains. Through storage and a gradual release of the storm water from the debris basins down to a series of detention basins strategically located within the proposed project site itself, Applicant and Staff planned to abate and mitigate the adverse and potentially catastrophic impact of storm water runoff on the BNSF Right-of-Way. Staff found that the installation of these basins would reduce the project's impact on site hydrology to less than significant. While the specific plans for the debris basins and detention basins had not been designed and were pending a comprehensive hydrology study, the general scheme of debris basins and detention basins was a major component of the proposed project for well over a year. The Energy Commission Certification Committee for the Calico Solar Project issued an order on September 3, 2010 finding that it could not support certification of the proposed project. The Committee order was based on a finding that the proposed project's impact on critical habitat outweighed the potential benefit of the proposed project. The September 3rd order noted that it would reconsider the proposed project if it were revised to reflect a smaller footprint that did not adversely impact so much critical habitat. In response, Applicant proposed six alternatives on September 7, 2010, all of which eliminated the debris and detention basin safety and mitigation measures. After a workshop on September 9, 2010, the Applicant further refined its proposed revised project to two alternatives, 5.5 and 6. Again, both of these alternatives eliminate the debris and detention basin safety and mitigation measures. Before further discussing these alternatives, however, I think it is important to review the Record in this matter in relation to debris and detention basins. I have reviewed the history of debris and detention basins in the Record in this matter in order to form the opinions contained herein. My observations follow:

<u>Chronology of References to Debris and Detention Basins</u>

December 2, 2008. Application for Certification ("AFC"). AFC notes that the Project Area is an unmapped area by FEMA. FEMA designates the Project Area as a "Zone D" area – meaning it is possible but undetermined flood hazards. [AFC at 5.5-6.] AFC notes that a 100-year flood[1] will flow southwest from the Cady Mountains through the Project Area. Flooding will pass through the BNSF RoW trestles and along the RoW. According to the AFC, "[t]he Project will not adversely affect existing drainage features. The existing flooding patterns will remain once the Project is constructed. [AFC at 5.5-10.]

By April 2009, Applicant had responded to numerous data adequacy requests and noted that, "[f]rom a surface water perspective, the Project will create new impervious surfaces that will have the potential to create additional runoff and subsequent erosion and sedimentation." [Supplemental Response

[1] To put this in perspective, there is a one percent probability that a catastrophic storm of a specific magnitude could occur in any given year. Personally, I am aware of two 100-year intensity flood events happening in 2006 in Albuquerque, NM.

at WATER-1.] Best Management Practices ("BMP's") being considered by the Applicant include "sediment basins" and "detention/infiltration basins." [Supplemental Response at WATER-11.]

After a series of workshops covering various aspects of the Project, Applicant submitted in February 2010 a Drainage Layout Figure that reflects a series of "debris basins" along the northernmost border of the Project Site. [February 12, 2010 Drainage Layout Figure.]

On March 30, 2010, the CEC and BLM issued the Staff Assessment/Draft Environmental Impact Statement ("SA/DEIS"). According to the Executive Summary, "[t]hese project debris basins are designed to retain storm water discharge and associated debris resulting from a 100-year flood." [SA/DEIS at ES-5.] The SA/DEIS noted that the debris basins were located on the northernmost border of the Project Site and, if the Site footprint was reduced under the Reduced Acreage Alternative [as it was], that the "flood intercept debris collection and flow detention basins would need to be similarly designed and constructed downstream from the southern boundary [of the lands no longer included in the Project Site as a result of the Reduced Acreage Alternative]." Assuming this was done, there would be "no change to the CEQA Level of Significance Impact." [SA/DEIS at ES-24 (implying that failure to do so would constitute a change to CEQA Level of Significance Impact).

Under the Biological Resources Section, the SA/DEIS identified thirteen major components of the Proposed Project, including "[s]tormwater detention basins, debris basins, and diversion channels." [SA/DEIS at C.2-11.]

The SA/DEIS Section on Hydrology,/Soil & Water makes a finding that the proposed project "could result in impacts that would be significant with respect to California Environmental Quality Act significance criteria specified herein and National Environmental Policy Act significant criteria specified in 40 CFR 1508.27," and makes it clear that the detention basins are an essential mitigation measure in the Project.

> "A Draft Drainage, Erosion, and Sedimentation Control Plan mitigates the potential project-related storm water and sediment impacts. However, the calculations and assumptions used to evaluate potential storm water and sedimentation impacts are imprecise and have limitations and uncertainties associated with them such that the magnitude of potential impacts that could occur cannot be determined precisely. Based on these factors, the proposed project could result in impacts that would be significant with respect to California Environmental Quality Act significance criteria specified herein and National Environmental Policy Act significant criteria specified in 40 CFR 1508.27. Therefore, Conditions of Certification **SOIL&WATER-1, SOIL&WATER-2** and **SOIL&WATER-3** have been developed that define specific methods of design analysis, development of best management practices, and monitoring and reporting procedures to mitigate impacts related to flooding, erosion, sedimentation, and stream morphological changes. Compliance with

> [Laws, Ordinances, Regulations and Standards ("LORS")], particularly the Clean Water Act requirements, will insure no adverse impacts to waters of the U.S. **With implementation of these Conditions,[2] the potential effects of the proposed project would be less than significant**. The applicant has not provided information necessary to complete the development of requirements for dredge and fill in waters of the state. Once the applicant provides this information staff can complete the development of requirements that will be included in Condition of Certification."

[SA/DEIS at C.7-1-C.7-2 (emphasis added).]

The SA/DEIS makes it clear that there will be impacts to the BNSF RoW:

> "Localized channel grading is proposed to take place on a limited basis to improve channel hydraulics in the vicinity of BNSF railway right-of-way to control the surface runoff. In addition, the Main Services Complex will be protected from a 100-year flood by berms and/or channels that will direct the flow around the perimeter of the building site, if required.
>
> The proposed arterial roadway section between the Main Services Complex and I-40 will be a designated evacuation route. As such, the driving surface will be constructed at an elevation above the projected profile of a 25-year storm event. In addition, overflow resulting from the 100-year storm event will be limited to a depth not to exceed 7 inches. It is anticipated that roadway maintenance will be required after rainfall events. For minor storm events, in

[2] These Conditions of Certification evolved into SOIL&WATER-8.

addition to the aforementioned maintenance, roadway repairs may be required due to possible damage to pavement where the roadway crosses the channels and where the flows exceed the culvert capacity. Soft bottom storm water detention basins will be constructed to mitigate the increase in runoff from the proposed building sites. Rainfall from paved areas and building roofs will be collected and directed to the storm water detention basins. The storm water detention basins will be sized to hold the entire volume from the proposed building sites resulting from a 24-hour, 100-year storm. The detention basin will be designed so that the retained flows will empty within 72 hours after the storm to provide mosquito abatement. This design can be accomplished by draining, evaporation, infiltration, or a combination thereof. The post-development flow rates released from the project site are expected to be less than the pre-development flow rates. Except for the building sites, the majority of the project site will remain pervious, as only a negligible portion of the site will be affected by pavement and SunCatchers foundations. Site drainage during construction will follow predevelopment flow patterns, with ultimate discharge to the BNSF ROW and ultimately at the westernmost property boundary.

Debris basins and/or low-flow culverts consisting of a small diameter storm drain with a perforated stem pipe will be installed for sediment control and to provide for storm peak attenuation.

BMPs for erosion and sediment control will be used in combination with debris basins for roadway crossing of major washes. In the Main Services Complex, the storm water will be directed to a detention basis, where the site runoff will infiltrate and/or evaporate. The detention basin will be sized to meet the San Bernardino County development criteria.

The temporary erosion and sedimentation control measures to be used during construction will be designed to prevent sediment from being displaced and carried off-site by storm water runoff. Before beginning excavation activities, debris basins, silt fence, straw bales, or other BMPs will be constructed/installed along the perimeter of the Project, where minor runoff to off-site areas could occur. Debris basins will be constructed for the major site runoff discharge and will also provide for low flow detention. The silt fence will filter sediments from construction runoff. Berms with perforated risers will be used at road crossings and other locations as needed to control sediment transportation. During construction, the extent of earth disturbances will be minimized as much as practical. A sediment trap will be located immediately upstream of the property boundary.

Diversion swales with berms will be constructed as necessary to divert runoff from off-site areas and on-site undisturbed areas around the construction site. Temporary BMP control measures will be maintained during the rainy season as necessary throughout the construction period.

[SA\DEIS at C.7-29.]

The Supplemental Staff Assessment of July 21, 2010 ("SSA") notes that large debris basins are being designed to control runoff and sedimentation. The SSA makes the following finding: "Impacts due to flooding in these areas are potentially significant without adequate mitigation. This leaves portions of the project subject to significant adverse impact due to flooding." [SSA at C.7-2.]

During the evidentiary hearings, Mr. Byall testified for Applicant extensively about the detention basins. According to Mr. Byall, the detention basins are designed, among other things, to reduce the impact on the RoW due to sediment buildup as a result of storms:

> What we're trying to do is not create an adverse condition where we will increase scour within the washes themselves and cause degradation of the washes; so we're trying to come up with a balance between what naturally occurs <u>and the interference we're going to cause by installing the SunCatchers</u> and the maintenance that would be required because of that. So it's a little bit of a balancing act.
>
> What we're trying to do is make it so that we don't have to go out after <u>every storm that creates a fair amount of flow and go out and remove a whole bunch of sediment from our at-grade crossings</u>, ...

[Testimony of R. Byall, 8/6/2010 TR at 35:12-24 (emphasis added).]

Staff Counsel extensively cross examined Mr. Byall and Mr. Moore of Applicant regarding the detention basins and the fact that Applicant kept changing the numbers and sizes of the detention basins. Staff expert Mr. Weaver testified extensively about how Applicant kept changing the numbers and sizes of the detention basins. [See Testimony of C. Weaver, 8/6/2010 TR at 41:11-46:21.]

Moreover, there was extensive cross examination designed to establish that, as of the hearing, Applicant still did not have an actual layout and design of the detention basins. Indeed, Mr. Weaver noted that Applicant testified to yet additional changes to the design plans for the detention basins on the third day of evidentiary hearings in Barstow.

MS. HOLMES: And this morning you heard testimony about yet additional changes to the proposed plans; is that correct?

MR. WEAVER: Yes, just this morning.

[Testimony of C. Weaver, 8/6/2010 TR at 46:22-25.]

Mr. Weaver explained that it was very difficult for Staff to deal with the uncertainty regarding the design of the debris and detention basins, but that "Soil and Water 8 was written to assure that the applicant will develop an appropriate design and will construct adequate flood control features that will protect the site from flooding hazards."]Testimony of C. Weaver, 8/6/2010 TR at 47:17-20.] As Mr. Weaver further explained, "[c]ompliance with Soil and Water 8 will protect the project from flow – excuse me, from flood hazards resulting from the hundred-year storm while allowing pass-through of flows resulting from smaller storms to replenish sediment in channels allowing groundwater recharge along the drainages which will maintain the function of the desert washes." [Testimony of C. Weaver, 8/6/2010 TR at 47:21-48:2.] After Staff counsel noted that Applicant had asked that same morning to substitute SOIL&WATER-8 and that Staff opposed this request, counsel for applicant stipulated to SOIL&WATER-8:

MS FOLEY GANNON: Hearing Officer Kramer, Ms. Holmes, we have an offer to make that may simplify some of this discussion.

The applicant is willing to stipulate to Soil and Water 8 and agree with its inclusion.

[8/6/2010 TR at 49:1-5.]

Until the development of Alternatives 1 through 6 and Dr. Chang's report of September 8 with requested change to SOIL&WATER-8, SOIL&WATER-8 clearly called for detention basins. In reliance on Applicant's stipulation, Staff shifted to a different topic. Moreover, BSNF did not examine Mr. Weaver based on Applicant's stipulation to SOIL&WATER-8. Furthermore, the day before, on August 5th, counsel for BNSF specifically asked Applicant if it would agree that the proposed Condition of Certification in the written testimony of Thomas Schmidt, Exhibit 1102, was reasonable, to include the following language – "applicant represents that applicant will deliver the following documents to BNSF: 1) Final drainage report; 2) final detention basin designs/plans; and 3) maintenance plan. At the time of delivery applicant will address any comments or concerns of BNSF. If there are any amendments to these documents or if there are alterations to any of the detention basins applicant will deliver such revisions to BNSF. " [8/5/2010 TR at 330:18-25.] Hearing Officer Kramer asked, "Does any party want to comment on that, including the applicant, on that? I guess it's more or less a stipulation." [8/5/2010 TR at 331:20-222.] To which counsel for Applicant responded, "No, we agree to the language." [8/5/2010 TR at 331:23.][3]

[3] Consistent with this stipulation, before the close of the evidentiary hearings on August 25th, counsel for Applicant confirmed the stipulation. Applicant clarified that Applicant agreed to pay for a hydrology study by an expert of BSNF's choosing and that Applicant would pay for all necessary mitigation measures: "MS. FOLEY GANNON: So we said, 'Prior to installing any SunCatchers or construction of the detention basins, project owners shall pay for a hydrology study commissioned by BNSF, which will determine the impact, if any, on the rail safety and BNSF operation of its planned placement of SunCatchers and detention basins and determined appropriate mitigation measures, if necessary, to be paid for by project owner.'" [8/25/2010 TR at 317:10-17.]

The Bureau of Land Management ("BLM"), issued its Final Environmental Impact Statement ("FEIS") on August 3, 2010. The FEIS indicates that the detention basins were included as part of the proposed project to mitigate the adverse impacts that would result from the project. The FEIS Hydrology section states: "Due to the project area's susceptibility to flash flooding and prolonged periods of precipitation, high intensity and short duration runoff events coupled with earth disturbance activities could result in accelerated on-site erosion.... Off-site flow would be intercepted prior to entering the project site using large debris basins constructed on-site and located at the toe of each mountainous drainage basin.... On-site runoff would be intercepted in detention basins which would be sized to retain the 100-year on-site stormwater discharge runoff and debris flows...." [FEIS at 4-362.]

The FEIS further provides that, "The Applicant has conducted mathematical calculations and probabilistic modeling to estimate anticipated potential impacts. Site development for the Proposed Action would result in direct, adverse, long-term impacts on surface hydrology on the project site due to a loss of on-site ephemeral drainages which promote groundwater recharge, flood peak attenuation, floodwater storage, and wildlife corridors and habitat. However, impacts would be localized and would be effectively mitigated with the implementation of mitigation measures required for the Proposed Action." [FEIS at 4-364.]

The FEIS further states: "Migration of channels and local scour caused by stormwater flows could remove sediment supporting individual poles and cause them to fall to the ground. Once on the ground during a storm event, the broken glass associated with the mirrors could further break and be transported downstream. Also, the SunCatcher structure itself and the associated wiring, could be transported downstream. Although the security fence located on the downstream side of the project site could stop larger pieces from leaving the property, it would not stop small glass fragments. Also, the fence itself could be damaged by stormwater flows and may not guarantee the onsite capture of all damaged materials. The detention/debris basins inside the northern boundary of the project site would be of sufficient size to completely retain flood flows resulting from a 100-year flood. Following significant storms, retained water would be released into the existing channels in a controlled and metered manner at a rate that is designed to not cause damage to SunCatcher pole foundations located within the channels." [FEIS at 4-371-372.]

Under the FEIS, the proposed mitigation measures for the proposed project include that the Applicant must obtain both BLM's Authorized Officer's and the Committee Presiding Member's approval for a site specific Drainage, Erosion and Sediment Control Plan (DESCP) that ensures protection of water quality and soil resources of the project site and all linear facilities for both the construction and operation phases of the project, and the DESCP must meet a number of requirements set forth in the FEIS. [FEIS at 4-379.] Also, the Applicant must ensure that all SunCatcher pole foundations are designed to withstand stormwater scour from surface erosion and/or channel migration, and that a stormwater Damage Monitoring and Response Plan be developed to evaluate potential impacts from stormwater. [FEIS at 4.382.]

As recently as August 26, 2010, Applicant submitted its proposed SOIL&WATER-8 to the CEC Committee. SOIL&WATER-8 specifically included detention basins. [See Exhibit 113.]

On September 8, 2010, in response to the CEC Committee's request that the Applicant consider a smaller project site, Applicant submitted a report by Howard Chang, Ph.D, P.E., which now recommends that detention basins not be installed. Dr. Chang's report contains a revised SOIL&WATER-8 that excludes any reference to detention basins.

On September 13, 2010, Applicant submitted testimony in support of two proposed reduced acreage sites within the proposed project area – Alternate 5.5 and 6. Both Alternatives eliminate any debris or detention basins. Dr. Chang makes no reference to the fact that Applicant and Staff had, for over a year, recommended that the project site be constructed with a scheme of debris and detention basins to control stormwater impact. According to Dr. Chang's testimony he does not recommend the installation of detention basins because they "can be a safety hazard for SunCatchers" and because of the "potential adverse impacts of the detention basins on the fluvial system." [Chang Report at p. 14.] Mr. Byall made no reference to his prior recommendation that the project site include detention basins and testified in a conclusory manner that "[n]o debris or detention basins are planned for the site." [Byall at p. 1.] Mr. Moore testified that "[i]t is likely that additional maintenance will be required on the project site in the absence of the previously proposed detention basins." [Moore at ¶6.] Ms. Bellows has requested that SOIL&WATER-8 be modified to delete any reference to debris and detention basins. [Bellows at pp. 3-4.]

Q4 Have you reviewed the testimony of Dr. Chang and Messrs. Byall and Moore submitted by Applicant in support of Alternatives 5.5 and 6?

A.4 Yes, I have.

Q.5. In your opinion, is there adequate support for Dr. Chang's conclusion that detention basins are not recommended?

A.5. No.

Q.6 Why not?

A.6 Dr. Chang asserts that "the proposed solar units will have insignificant effects on the arid-land hydrology of the project site." I disagree. The Record is clear that stormwater flows across the proposed site in a southwesterly direction until it reaches the BNSF Right-of-Way, and then flows west. This has the most direct and significant impact on Sections 07 and 12 within the proposed project site. Before the Applicant was told it had to reduce its project site footprint, both Applicant experts – Messrs. Byall and Moore, as well as Staff expert Mr. Weaver – all agreed that the placement of the SunCatchers, together with the main service complex and substation foundations and pads, the hundreds of miles of roadways that interlace the project site and afford Applicant the ability to perform maintenance on the site, and other features and structures that will necessarily be built on the site will adversely affect the stormwater flow on the site. In turn, this will likely cause increased sediment build up along the BNSF Right-of-Way and also increase the risk of adverse impacts to backslopes, ditches, culverts, and trestles within the Right-of-Way. Ultimately, it will increase the risk of stormwater disrupting the transcontinental mainline. There is ample evidence of this fact and Dr. Chang does not present any evidence to the contrary. Contrary to Dr. Chang's assertions, alluvial fans are not stable and are not at equilibrium. The arid desert region, such as the proposed project area in the Mojave Desert, is subject to flash flood type events that leave new sediment deposits after every event. When a subsequent flood occurs it may establish a new route to the valley floor. This creates a system of braided stream channels found in most alluvial fans. Dr. Chang has oversimplified the complex morphology of this region in particular and alluvial fans in general.

In my professional experience, when structures are built upgradient of the Right-of-Way along an alluvial fan in a desert environment there is increased runoff and erosion along the Right-of-Way and typically we see backslope, ditch and culvert damage. This is simply because the structures on the upgradient development reduce the ability of the respective property to absorb stormwater, which in turn results in increased flow and increased damage. Dr. Chang's analysis does not appear to take this into account. Ultimately, the stormwater can wash out a track and cause substantial damage and lengthy interruptions in train service.

The BNSF Railway Company has experienced heavy rainfall events in this area with the water surface rising against the bridge girders. However, there is no record of historic floods overtopping the tracks. This historic flooding demonstrates that the current drainage system does not have additional capacity to spare and it is critical that the proposed Calico Solar development maintain historic flows. Any increases in flows or sediment to the railroad drainage could result in overtopping of the railroad tracks. Therefore the BNSF Railway Company requires more substantial analysis for the hydrology of the proposed development to demonstrate that the construction of 24,000 sun catcher, miles of maintenance roads, a 90 acre substation and the associated construction disturbance to the desert top soils will not change the existing drainage to the railroad structures.

Q.7 What is your opinion about the impact of emplacing the SunCatchers and associated infrastructure on the proposed Alternative 5.5 or Alternative 6?

A.7 In relation to this site, there will be over 24,000 SunCatchers placed in a tight grid over the site. Each SunCatcher has a 2 foot circumference base pedestal, which will be impervious to stormwater absorption and will act as a barrier to channelize stormwater, causing what is referred to as scouring around the base of the pedestal. Both Alternatives include provision for a large main services complex and a substation, with associated foundations and pads. Additionally, I understand that there will be an improved roadway along the entire border of the site and then access/maintenance roads between every other row of SunCatchers. The total estimated roadway is hundreds of miles. While not all of the roads will be paved, I understand all roads may be all-weather roads, which will be graded and either paved or treated with Soiltec or a similar substance to keep dust down. The resulting effect is that these roads will act as at least partial impervious barriers to the absorption of stormwater and will channelize stormwater flow and disrupt the natural flows of the alluvial fan. In addition, Applicant plans to place the SunCatchers as close together as physically possible in order to maximize the concomitant megawatt output from increased SunCatchers. While they will be "stowed" during a storm, the rainfall will naturally flow along the "stowed" surface of the SunCatcher, ensuring that the stormwater will run off the SunCatchers in a different fashion than if the site remained in its natural state, without SunCatchers.

Q.8 In your opinion, given the current state of hydrological analysis and issues raised by Calico Solar as recently as this week, does BNSF have sufficient information to analyze and grant Calico Solar's four requests for licenses and crossings on the BNSF ROW?

A.8 No. In the absence of an adequate study and in light of the issues raised by the Applicant through Dr. Chang's declarations and studies and Mr. Moore's declaration of September 13, 2010, it is not possible to analyze the safety or compatibility concerns raised by the requests that (1) BNSF allow it to drive hundreds of trucks and cars over the ROW; (2) BNSF build a new temporary at-grade crossing for Calico Solar's use in the ROW; (3) BNSF allow it to build a bridge over the BNSF ROW; and (4) BNSF allow an expansion of an at-grade crossing's use to allow for emergency access to the Calico Solar site. The proper studies, including hydrological, need to be completed. In addition, Calico Solar needs to disclose what is being referred to by the statement of Matt Moore of URS when he states that: "Existing sedimentation and maintenance issues at railroad facilities represent an existing condition that would not be significantly altered by Scenario 5.5 or 6." Once this information is obtained, BNSF will need time to evaluate if such uses and infrastructure are compatible with railroad infrastructure and operations and where they might best be located. BNSF needs to be provided the precise location of all SunCatchers and related infrastructure so it can assess potential impacts on the ROW that need to be considered in processing Calico Solar's applications. Until this occurs, BNSF is not in a position to grant the requested licenses and crossings.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: September 14, 2010

Steven J. Metro

Exhibit G

TESTIMONY OF DOUGLAS HAMILTON, P.E., D.WRE

PROPOSED CALICO SOLAR PROJECT, SAN BERNARDINO COUNTY, CALIFORNIA

Q.1 What is your name, occupation, and experience?

A.1 I, Douglas Hamilton, am a registered civil engineer in the State of California (License No. 42210). I am a Principal Engineer at Exponent, Inc. My area of specialization is water resources including flood hazards in arid regions including the sometimes ultra-hazardous processes such as high velocity water flow, uncertain flow paths, erosion, sediment deposition, transport of debris, and perilous impact forces. I have extensive local experience, knowledge of railroad hydrology in Southern California, and international experience in the types of flood hazards associated with alluvial fans. My practice includes identifying and mitigating flood hazards in both the pristine and developed desert regions of California. I have worked with many public and private experts who provide important information that is relevant to this type of hazard including Flood Control agencies in San Bernardino and Riverside Counties. I served on the National

Research Council Committee on *Alluvial Fan Flooding*,[1] and as a consultant to the California Governor's Task Force on Flooding. Later, I served in a key advisory role in the California Governor's Task Force on Alluvial Fan Flooding.[2] My C.V. is attached as Exhibit 1 to this Declaration.

I have direct knowledge of hydrology, geology, geomorphology, sediment transport, and hazardous flooding conditions in the vicinity of the Cady Mountains in San Bernardino County. These types of process affect the Burlington Northern Santa Fe (BNSF) rail line and the proposed Calico Solar Project which is located both north and south of the BNSF line between Daggett and Ludlow in the vicinity of historic Hector, a former watering stop for steam locomotives. This subdivision of the BNSF track was originally built in the 1880's and 1890's. The Hector Station shows up on the United States Geological Survey (USGS) topographic maps that are shown in the background of most of the source maps prepared by the applicant from both

[1] Alluvial Fan Flooding, National Research Council, National Academy Press, Washington, D.C., 1996 http://www.nap.edu/openbook.php?isbn=0309055423

[2] California Governor's Alluvial Fan Task Force, California State University San Bernardino, Water Resources Institute, 2010
http://aftf.csusb.edu/documents/FINDINGS_Final_July2010_web.pdf
http://aftf.csusb.edu/documents/IA_Final_July2010_web.pdf
http://aftf.csusb.edu/documents/FACT%20SHEET_Plenary%2010%20Distribution_Mar2010.pdf

Thank you for your comment, Anne Alexander.

The comment tracking number that has been assigned to your comment is SolarD11903.

Comment Date: May 3, 2011 02:10:55AM
Solar Energy Development PEIS
Comment ID: SolarD11903

First Name: Anne
Middle Initial:
Last Name: Alexander
Organization: Katten Muchin Rosenman LLP
Address: 2029 Century Park East
Address 2: Suite 2600
Address 3:
City: Los Angeles
State: CA
Zip: 90067
Country: USA
Privacy Preference: Don't withhold name or address from public record
Attachment: BNSF Comments to Draft Solar PEIS Part 2..pdf

Comment Submitted:

the California Energy Commission (CEC)[3] and the United States Bureau of Land Management (BLM)[4].

Q.2 Are extreme alluvial fan flooding, erosion, and debris flow hazards associated with active alluvial fans at the proposed Calico Solar Site?

A.2 The proposed Calico Solar site is on an active alluvial fan. Significant information exists that confirms the alluvial fans and the associated flooding hazards emanating from the Cady Mountains are located within and pass through the proposed Calico Solar project area. The proposed Calico project area also extends south of the existing BNSF track down to Interstate 40 (I-40) shown on the USGS topographic provided as Exhibit 2 attached to this declaration. The project boundary on Exhibit 2 is the one originally proposed by the applicant.

The Existing Conditions Hydrologic and Hydraulics Study prepared for the applicant by Huitt Zollars on April 23, 2009, Binder 1, Exhibit A shows a Geomorphic Hazard Map for the project area. Basically, this map concludes that virtually the entire area between the foot of the mountains

[3] http://www.energy.ca.gov/sitingcases/calicosolar/documents/index.html
[4] http://www.blm.gov/ca/st/en/prog/energy/fasttrack/calico.html

down to the BNSF Railroad is subject to either Severe or High Hazard Levels. Severe and High Hazards mean that high velocity flows, debris flows, unpredictable flow paths, and sediment movement characterize the flood hazards at the site in its existing condition. The applicant and their consultants have not provided an updated map showing that these types of hazards are non-existent in this area. In fact, in 1966, T.W. Dibblee and A.M. Bassett working for the California Division of Mines and Geology, prepared a surficial geology map with cross sections for the area. The map is consistent with the Geomorphic Hazard Map in the Huitt Zollars report and shows that the proposed Calico Solar Site is on an active alluvial fan area composed of Recent Alluvium and Recent Alluvium Fan Gravel (See Exhibit 3). The project boundary shown on Exhibit 3 is the one original proposed by the applicant.

Because the flooding sources emanating from the Cady Mountains flow onto a series of alluvial fans, the direction of flow and the amount of flow in any given desert wash further down the fan is unpredictable. In fact, entirely new desert washes can be formed during a single flood event. This element of randomness is one of the factors that makes flooding on alluvial fans so hazardous.

Appendix G of the FEMA guidelines (See Exhibit 4) for analyzing floods on alluvial fans states that for active alluvial fan areas, the prudent assumption is that all of the water from the apex of the fan could reach any point on the fan and, therefore, the target area where a facility is being designed should accommodate the erosion, sediment, and water from the full flow that emanates from the fan apex.

In a letter dated September 10, 2010 to the CEC, Tessera Solar provided two revised project alternatives identified as Scenarios 5.5 and 6. These scenarios move the northern project boundary south avoiding Sections 4 and 5 as well as make other adjustments. The project layout and proposed drainage patterns for Scenario 5.5 is overlaid on a recent aerial photograph and is shown in Exhibit 5. As can be seen from the aerial photo, the site is still subject to random flood flow paths characteristic of active alluvial fans. Instead of benign, shallow sheet flow spreading out over the surface of the desert floor, water emanating from the Cady Mountains will concentrate in existing drainage paths as well as new ones created during a flood event. This is why critical infrastructure on alluvial fans should have structural flood control measures to collect and convey floodwater around and/or through the project.

A review of the proposed project alternative in a letter from Tessera Energy dated February 12, 2010 to the CEC shows Figure 12 from URS. This plan indicates that a series of stormwater collection devices on the northern boundary would partially separate the project from stormwater flow from the Cady Mountains. This essentially surrounds the project and addresses the uncertainty of flow paths on the alluvial fans. This approach could be designed in a way such that sediment passes through the system and not trap sediment. In fact, bypassing sediment through constructed flood control facilities is a common practice in desert regions both to reduce maintenance and to preserve the environment downstream. Even though Scenarios 5.5 and 6 are moved further from the base of the mountains, eliminating flood protection measures at the northern boundary will subject the site to the full force of alluvial fan flooding.

Q.3 Do you have an opinion on whether the sediment, erosion, and flooding studies prepared by Howard H. Chang Ph.D., P.E. are inadequate, factually incorrect, and do not propose required mitigation to protect the proposed Calico Solar Project and prevent impacts to the BNSF right of way?

A.3 In the study by Howard H. Chang, Ph.D., P.E. entitled Sediment Study for Washes at Calico Solar Project Site in San Bernardino County (Original Chang Study) dated July, 2010, no discussion of the unpredictability of flood flows from alluvial fans is presented. In a paper dated November 1982 entitled Fluvial Hydraulics of Deltas and Alluvial Fans, Dr. Chang state, "Streams on deltas and alluvial fans that are formed in noncohesive alluvium are characterized by unstable channel geometries."[5] However, he does not include the unstable and unpredictable nature of channel behavior in the alluvial fan analyses for the Calico Solar Project site.

The Original Chang Study relies on the use of a hydraulic and sediment transport computer program known as FLUVIAL-12. It should be noted that this computer program is not on the list of programs accepted by FEMA for use in analyzing floods on alluvial fans nor for use in rivers (See Exhibit 6). Estimates of pier scour depth for the 2-foot diameter foundation for each of the proposed solar devices range from 3.14 feet to 4.61 feet deep based on the depth of

[5] Chang, H.H. Fluvial Hydraulics of Deltas and Alluvial Fans. ASCE Journal of the Hydraulics Division. November 1982.

water flow (page 17). However, the standard formula from the Federal Highway Administration referenced on page 11 of the Original Chang Report is incorrect.

The Federal Highway Administration (FHWA) formula for local scour around round-nosed piers/bents or cylindrical piers/bents is incorrectly quoted in Dr. Chang's July 2010 report. The actual formula in Hydraulic Engineering Circular No. 18, labeled as Equation 6.1, reads as follows[6]: $y_s/y_1 = 2.0*K_1*K_2*K_3*K_4*(a/y_1)^{0.65}*Fr_1^{0.43}$. These factors are important to consider in order to estimate scour depths for alluvial fans.

Furthermore, a review of the FLUVIAL-12 computer program output file labeled FAN-WASH.TXT indicates that the water flow calculations were based on a hypothetical channel carrying only 40 cubic feet per second (cfs) of flood water. Whereas, Figure 4, Page 9 shows a hydrograph involving a maximum flow of approximately 10,000 cfs. Combining the use of an incomplete scour equation and underestimating the amount of stormwater flow through the site means that both the depth and length of scour holes around the 2-foot diameter piers could be much greater than

[6] Federal Highway Administration. Hydraulic Engineering Circular No. 18. Evaluating Scour at Bridges Fourth Edition. Publication No. FHWA NHI 01-001, May 2001. Available online at: http://www.fhwa.dot.gov/engineering/hydraulics/library_arc.cfm?pub_number=17&id=37. Accessed September 17, 2010.

reported and could impact natural flow patterns which ultimately impact down gradient areas, including the BNSF right of way.

On September 8, 2010 Dr. Chang prepared a report entitled Assessment of Detention Basins / Debris Basins for Calico Solar Site (Revised Chang Report). In this report, he recommends the removal of what are referred to as basins from the northern boundary of the Calico Solar project. My examination of the actual function of the proposed basins would be to funnel offsite stormwater into discrete, discernable flow paths. The decision to eliminate all of the flood hazard control at the northern boundary of the Calico Solar Project is unsound as the projected stormwater flows cited in the Original Chang Study are on the order of 10,000 cfs. Should a significant portion of the flow be concentrated in a flow path that does not exist today, it could damage the Calico Solar Project. Furthermore, the localized scour around the cylindrical concrete foundations of the proposed SunCatchers could be much greater than predicted by the Original Chang Study and divert floodwaters to areas along and within the BNSF right of way this could undermine the track embankment and the bridge crossings.

In the Original Chang Study, the predicted scour depth around the 2-foot diameter foundation post supporting the SunCatchers assumes water spreads as sheet flow. This assumption does not account for the random effects of hazardous flows on alluvial fans where a large percentage of the water from the apex of the alluvial fan reaches the pier rather than spreading out and dissipating. The original option of collecting and funneling offsite flows into discrete flow through paths is reasonable and necessary.

I do not believe this type of critical flood protection element at the northern boundary of the Calico Solar Project should be eliminated as an option in the proposed hydrology study.

Q.4 Does the currently proposed Calico Solar Project ignore potential flood hazard impacts on the existing BNSF Right of Way, I-40, and to the project itself?

A.4 The original proposal from the applicant to the CEC showed that there would be floodwater collection devices, detention basins, debris basins, or some other type of device to better control the uncertainties of hazardous flood processes on the alluvial fans at the northern boundary of the proposed Calico Solar Project.

The Revised Chang Report, filed with the CEC, states that flood control measures at the northern boundary are not necessary. In fact, according to Dr. Chang, attempts at mitigating the alluvial fan flooding hazards could actually harm the Calico Project.

In response to Dr. Chang’s declarations to the CEC, the project engineers from URS decided to adopt a policy of reaction rather than one that includes direct flood hazard mitigation. The proposed approach by the project proponent is to wait and see what happens after a 5-year 24 hour storm which amounts to more than 1.5 inches of rain in one day. For desert environments, this amount of rain in one day can be problematic. These characteristics of desert environments are confirmed by the Huitt Zollars study and the West Consultants Appendix therein. In my experience, even after one-half inch of rain in this region, both roads and railroads are inspected for damage. Based on NOAA Atlas 14, the most recent compilation of rainfall statistics in the desert region, the 100-year storm amounts to more than 3 inches in 24 hours, which can cause severe erosion and deposition.

Q.5 What is the history of flood hazards related to railroad transportation in the Mojave Desert Region of California as it pertains to the this project?

A.5 The history of floods occurring in the Mojave Desert Region of California is documented in numerous hydrologic and geologic publications including some that stem from reconnaissance surveys and assessments performed in the early Twentieth Century. The United States Department of Interior Geological Survey (now the United State Geological Survey, USGS) noted in 1929 that there are substantial flood risks in the Mojave Desert:

> Storms, especially those occurring in the summer, frequently do great damage. At several places the crops of entire ranches have been washed away or buried by debris in a single storm. Large sums of money have been expended in protecting railroads from the floods that rush down from the mountains. Large drainage channels several thousand feet long are constructed to lead the floods to specially protected culverts, and concrete walls have been built at a

> number of places to protect the Atchison, Topeka & Santa Fe Railway. In spite of all these protective works sections of track are washed out every few months. Considerable damage is also frequently done to highways. Strangely enough, in this land, of little rain the monetary losses due to excessive rainfall probably exceeded those due to all other climatic conditions.[7]

Q.6 Do the Chang reports ignore the impacts of increasing the concentration of rainwater on localized areas of soil in desert environments and the detrimental effect of superimposing a gridded road system that does not follow the natural stormwater flow direction?

A.6 The railroad track in question has suffered damage from activities related to intensive adjacent land use. For example, in Hesperia and Victorville, California, large scale residential development decreased the ability of desert soils to absorb rainfall and directed ever

[7] US Department of the Interior Geological Survey. Water-Supply Paper 578 The Mohave Desert Region California. United States Government Printing Office, Washington. 1929. Available at: http://ngmdb.usgs.gov/Prodesc/proddesc_24591.htm. Accessed September 14, 2010.

increasing amounts of stormwater runoff toward the BNSF track. In the storms of 1992 and 1993, extreme erosion occurred near the tracks. This problem of increased impervious surfaces on desert lands and the concentration of the resulting water culminated on August 14, 2004 when the BNSF track at Milepost 39 and 41 in the Cajon Subdivision was undermined by stormwater runoff and collapsed (See Exhibit 7).

The September 15, 2010 Applicant's Submittal of Response to Sierra Club Data Requested on September 14, 2010 briefly discusses the changes in hydrology, drainage, erosion, and sedimentation that would result by adopting reduced footprint project scenarios. In the response to this query regarding potential impacts, it is explained that there is 3.14 square feet per 0.28 acres of the project site and that this relation is "too small…to cause significant impacts."[8] However, this statement is only referring to the concrete pedestal of the solar device.

The August 2010 Testimony by Marie McLean, James Jewell, and Alan Linsley, AIA discuss Traffic and Transportation

[8] This is discussed on Page 7 of the September 15, 2010 letter from Felicia L. Bellows of Tessera Solar to Christopher Meyer of the California Energy Commission regarding the Calico Solar (formerly Solar One) Project (08-AFC-13) Applicant's Submittal of Response to Sierra Club Data Requested September 14, 2010.

matters related to the Calico Solar Project. This document states that approximately 34,000 SunCatchers are proposed for the project, each of which is 11.5 meters (approximately 38 feet) in diameter. The area of each solar unit is approximately 1,130 square feet. These units rotate to take advantage of the angle of the sun and theoretically could be tilted or put in a "store" mode to minimize the interception of rainfall. However, rain does not always fall vertically downward. Winds can cause the rain to fall at an angle and could strike the solar panel. The resulting runoff could concentrate and create localized runoff. The project also includes a 14.4 acre "main services complex" and a 2.8-acre substation.[9] The only mitigation plan being proposed is to build a detention basin for increased runoff from the main services complex. The change to the local hydrology that could be caused by an approximate 24,000 SunCatchers is not acknowledged.

Item B.1.4.1 of the Staff Assessment and DEIS discusses that the original project has approximately 25 miles of paved roads, 168 miles of North-South dirt roads, and 102 miles of East-West Dirt Roads. The dirt roads are to be treated with a polymer for dust control and stabilization.

[9] Appendix C.11 – Traffic and Transportation. Testimony of Marie McLean, James Jewell, and Alan Lindsley, AIA. August 2010.

Increased runoff can be expected to occur as a result of the roads. Even the dirt roads will have decreased infiltration capacity from rainfall due to compaction by vehicle traffic and the hydrophobic nature of the chemicals typically applied to dirt roads.

The road systems used to access and maintain the solar panels are arranged in a North-South and East-West grid. This is contrary to the natural flow direction of water and debris along the alluvial fan is from Northeast to Southwest. Ultimately the system of dirt roads will serve as flood conveyance paths during large storms and change the way that water reaches the BNSF track potentially concentrating and eroding the track embankment.

The issues above are indicators that there are substantial impacts to land use resulting from the proposed Calico Solar Project including increased runoff and sediment transport. The Revised Chang Report essentially eliminates upstream flood protection on the Northern project boundary and does not revise, correct, or explain why it is prudent to deviate from the Geomorphic Hazard Map in the Huitt Zollars report. Furthermore, none of the 5 proposed flood protection alternatives from the Huitt Zollars report have been carried over to the Revised Chang Report. I agree with the Huitt Zollars report that without including some structural flood mitigation measure on the northern project boundary, that the solar units, and other infrastructure will be subject to severe and damaging flooding and erosion. Unmitigated, such damage and erosion will impact the BNSF railroad embankment by altering existing flow paths, increasing flood runoff, and increasing the amount of sediment and debris that will reach the BNSF tracks.

I declare under penalty of perjury that the foregoing is true and correct and that this declaration was executed on September 17, 2010 at Irvine, California.

Douglas Hamilton, P.E.

Registered by the California Board of Professional Engineers No. 42210

Exhibit 1

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Douglas Hamilton, P.E., D.WRE
Principal Engineer

Professional Profile

Mr. Douglas Hamilton is a Principal Engineer in Exponent's Civil Engineering practice. He has extensive experience in water resources, hydrology, and natural hazards in arid environments. He has developed and applied a wide range of analytical techniques in order to explain the hydrologic impacts of natural hazards. He is also an expert in the application of sediment transport, geomorphic and hydrologic principles to natural systems, and to the design of constructed facilities.

Prior to joining Exponent, Mr. Hamilton worked for the Hydrologic Engineering Center (HEC), which provides consulting and technology services to the civil works and military missions of the U.S. Army Corps of Engineers. While in the Research Branch of HEC, Mr. Hamilton was responsible for conducting flood hazard, sedimentation, and debris flow studies for Mount St. Helens, Washington, and for the Wasatch Front Range, Utah. He was also in charge of the computer program HEC-6, Sediment Transport in Rivers and Reservoirs. Mr. Hamilton has held lead engineering positions in the consulting firms Simons, Li & Associates, and Rivertech. For eight years prior to joining Exponent, Mr. Hamilton operated his own hydrologic consulting firm. He has taught a number of professional courses for hydraulic and sediment transport analysis techniques. He is a cooperating partner with the Chinese Academy of Sciences, Institute of Mountain Disasters and Environment (Sichuan, China), and has served as a committee member for the National Research Council's Water Science and Technology Board.

Academic Credentials and Professional Honors

M.S., Civil Engineering, University of California, Davis, 1984
B.S., Engineering, Harvey Mudd College, 1983

National Research Council's Water Science and Technology Board: Committee on the Evaluation of the National Flood Insurance Program Policy for Alluvial Fan Areas (member)

U.S. Delegation, International Conference on Natural Disaster Reduction, Yokohama, Japan, 1994 (observer); Sedimentation Technical Committee; American Society of Civil Engineers (past chair); Consultant to the California Governor's Task Force on Flooding; Trade Partner of the Year 2005 Pulte Homes, Del Webb; Technical Consultant to the California Governor's Alluvial Fan Flooding Task Force; Metropolitan Water District; Mobil Land Development; Pacific Ocean Division of the U.S. Army Corps of Engineers; Saddleback Valley Unified School District; Safeco Insurance Company; Santa Fe Railroad; and the World Bank; Technical Consultant to the California Governor's Alluvial Fan Flooding Task Force; Metropolitan Water District; Mobil Land Development; Pacific Ocean Division of the U.S. Army Corps of Engineers; Saddleback Valley Unified School District; Safeco Insurance Company; Santa Fe Railroad; and the World Bank

Licenses and Certifications

Registered Professional Civil Engineer, California, #42210; Licensed Professional Engineer, South Carolina, # 23305; Diplomate, Water Resources Engineer, American Academy of Water Resources Engineers, 2008

Publications and Presentations

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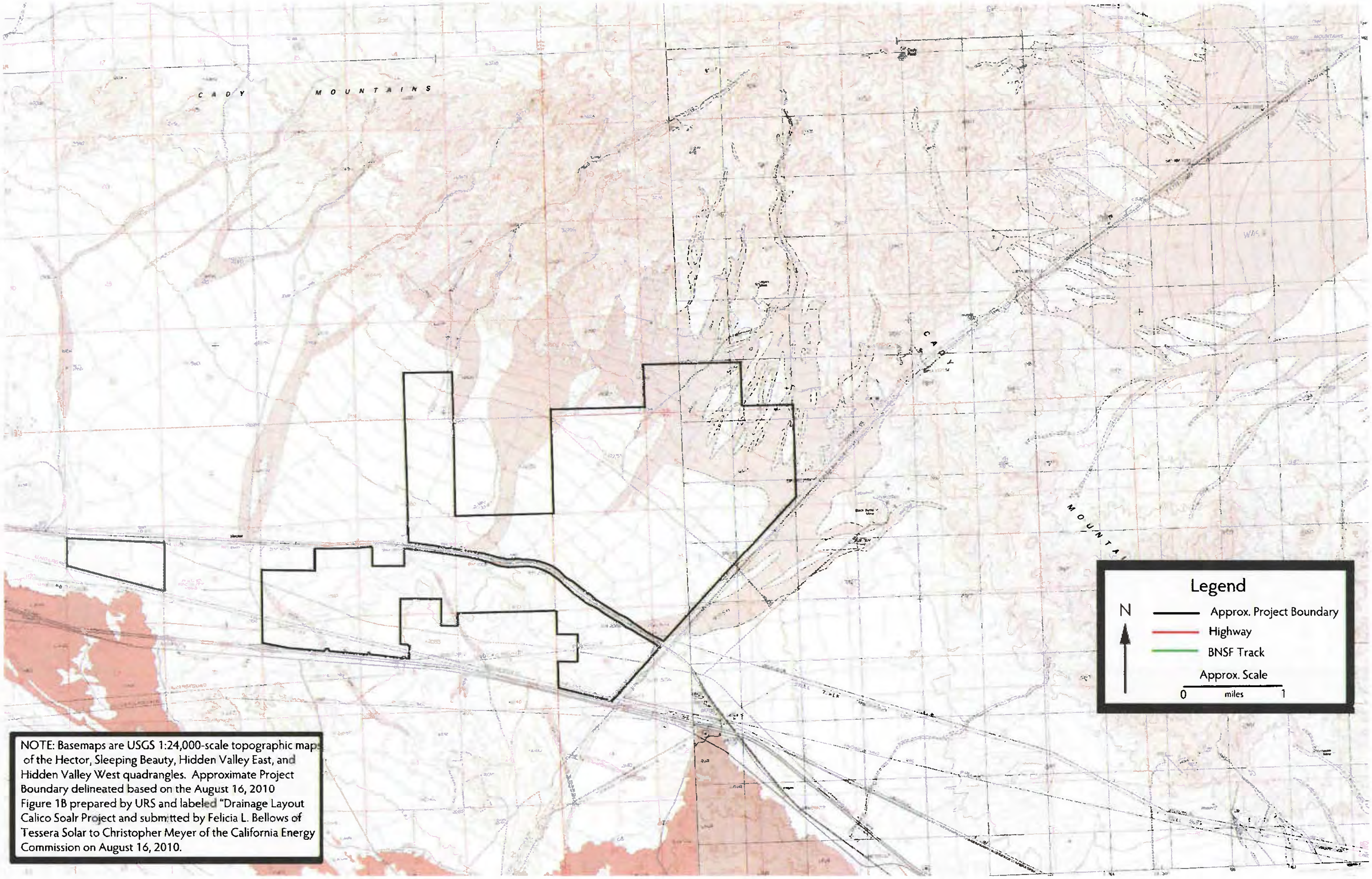
Exhibit 2



CADY MOUNTAINS
CADY MOUNTAINS
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Approx. Project Boundary
Highway
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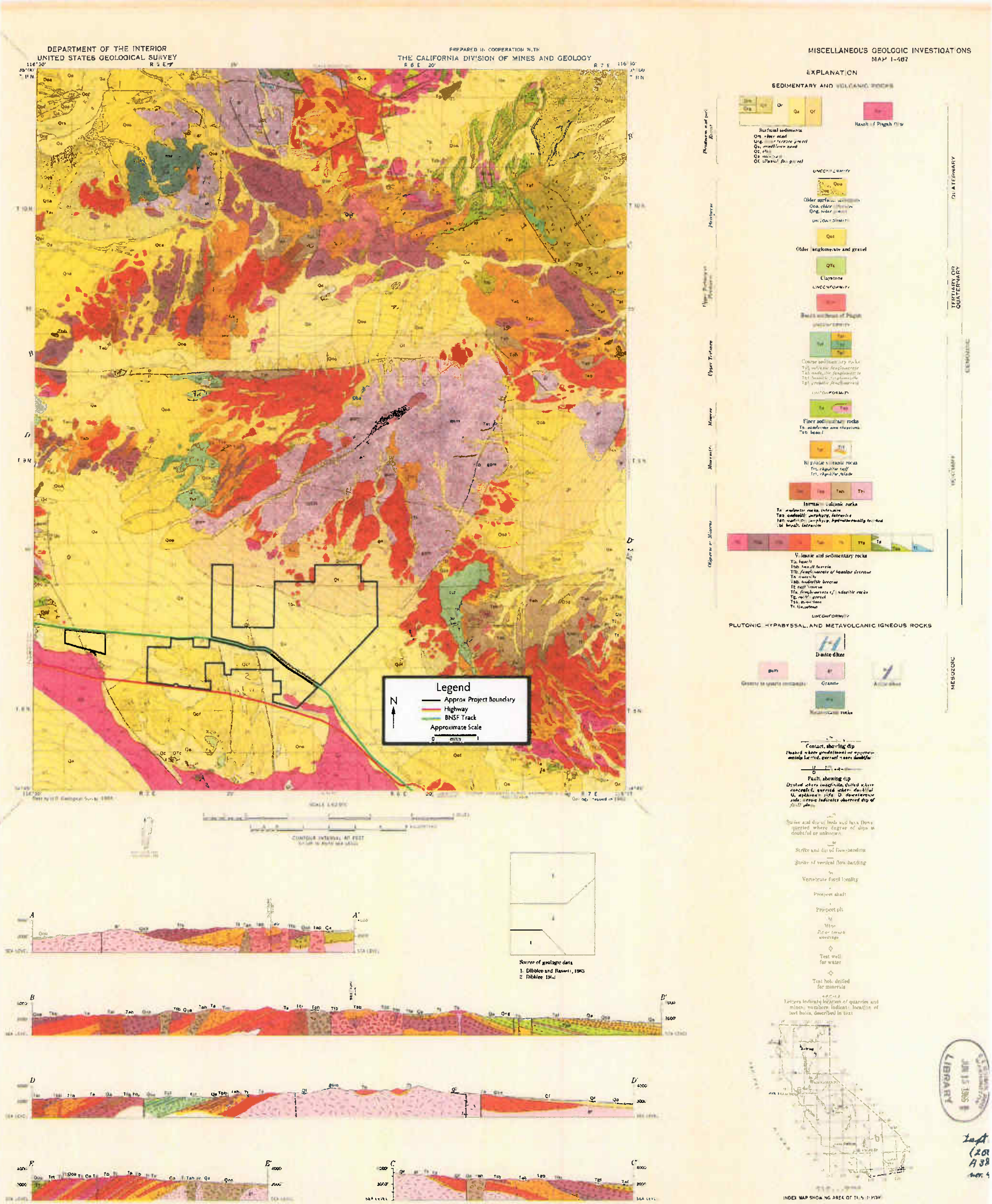
NOTE: Basemaps are USGS 1:24,000-scale topographic maps of the Hector, Sleeping Beauty, Hidden Valley East, and Hidden Valley West quadrangles. Approximate Project Boundary delineated based on the August 16, 2010 Figure 1B prepared by URS and labeled "Drainage Layout Calico Soalr Project and submitted by Felicia L. Bellows of Tessera Solar to Christopher Meyer of the California Energy Commission on August 16, 2010.

Exhibit 3



GEOLOGIC MAP OF THE CADY MOUNTAINS QUADRANGLE, SAN BERNARDINO COUNTY, CALIFORNIA

By
T. W. Dibblee, Jr., and A. M. Bassett

1966

Exhibit 4

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/fhm/dl_cgs.shtm

April 2003

Summary of Changes to Appendix G,

Guidance for Alluvial Fan Flooding Analyses and Mapping

The Summary of Changes below details changes to Appendix F that were made subsequent to the initial publication of these *Guidelines* in February 2002. These changes represent new or updated guidance for Flood Hazard Mapping Partners.

Date	Affected Section(s)/Subsection(s)	Description of Changes
April 2003	None	No changes representing new or updated guidance were made.

Appendix G

Guidance for Alluvial Fan Flooding Analyses and Mapping

G.1 Introduction **[February 2002]**

Alluvial fans, and flooding on alluvial fans, show great diversity because of variations in climate, fan history, rates and styles of tectonism, source area lithology, vegetation, and land use. Acknowledging this diversity, the Federal Emergency Management Agency (FEMA) developed an approach that considers site-specific conditions in the identification and mapping of flood hazards on alluvial fans. This approach, summarized herein, was first documented in *Guidelines for Determining Flood Hazards on Alluvial Fans*.

Investigation and analysis of the site-specific conditions may require knowledge in various disciplines, such as geomorphology, soil science, hydrology, and hydraulic engineering. Although the scope of study may constrain the degree of site-specific consideration undertaken, field inspections of the alluvial fan must be conducted.

According to Section 59.1 of the National Flood Insurance Program (NFIP) regulations, the current definition of "Alluvial Fan Flooding" means

> flooding occurring on the surface of an alluvial fan or similar landform which originates at the apex and is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and, unpredictable flowpaths.

FEMA will revise the current definition under Section 59.1 to be consistent with the approach described in this Appendix and specifically to eliminate reference to "similar landforms." The process described in this Appendix is intended for flooding only on alluvial fans as described below.

As interim guidance in the determination of "similar landform," unless the landform under investigation meets the three criteria under Stage 1 for composition, morphology, and location, the landform is not considered to be "similar."

This Appendix provides guidance for the identification and mapping of flood hazards occurring on alluvial fans, irrespective of the level of fan forming activity. The term ***alluvial fan flooding*** encompasses both ***active alluvial fan flooding*** and ***inactive alluvial fan flooding***. Each type of alluvial fan flooding is described below.

Active alluvial fan flooding occurs only on alluvial fans and is characterized by flow path uncertainty so great that this uncertainty cannot be set aside in realistic assessments of flood risk or in the reliable mitigation of the hazard.

An active alluvial fan flooding hazard is indicated by the following three related criteria:

1. Flow path uncertainty below the hydrographic apex;
2. Abrupt deposition and ensuing erosion of sediment as a stream or debris flow loses its ability to carry material eroded from a steeper, upstream source area; and
3. An environment where the combination of sediment availability, slope, and topography creates an ultrahazardous condition for which elevation on fill will not reliably mitigate the risk.

Inactive alluvial fan flooding is similar to traditional riverine flood hazards, but occurs only on alluvial fans. Inactive alluvial fan flooding is characterized by flow paths with a higher degree of certainty in realistic assessments of flood risk or in the reliable mitigation of the hazard. Unlike active alluvial fan flooding hazards, an inactive alluvial fan flooding hazard is characterized by relatively stable flow paths. However, like areas of active alluvial fan flooding, inactive alluvial fan flooding may be subject to sediment deposition and erosion, but to a degree that does not cause flow path instability and uncertainty.

An alluvial fan may exhibit both active and inactive alluvial fan flooding hazards. The hazards may vary spatially or vary at the same location, contingent on the level of floodflow discharge. Spatially, for example, upstream inactive portions of the alluvial fan may distribute floodflow to active areas at the distal part of the alluvial fan. Hazards may vary at the same location, for example, with a flow path that may be stable for lower flows, but become unstable at higher flows.

An example of an alluvial fan that exhibits both active and inactive alluvial fan flooding is depicted in Figure G-1. In this example, the area between the topographic apex and the hydrographic apex (apex definitions will be discussed below) would be considered *inactive alluvial fan flooding* because this reach is characterized by a stable, entrenched channel which can convey the 1-percent-annual-chance (100-year) flood discharge without overbank flooding. The area below the hydrographic apex would be considered *active alluvial fan flooding* because this area is characterized by flow path uncertainty, abrupt deposition, and ensuing erosion of sediment as the channel loses its competence to carry material eroded from a steeper, entrenched upstream source area.

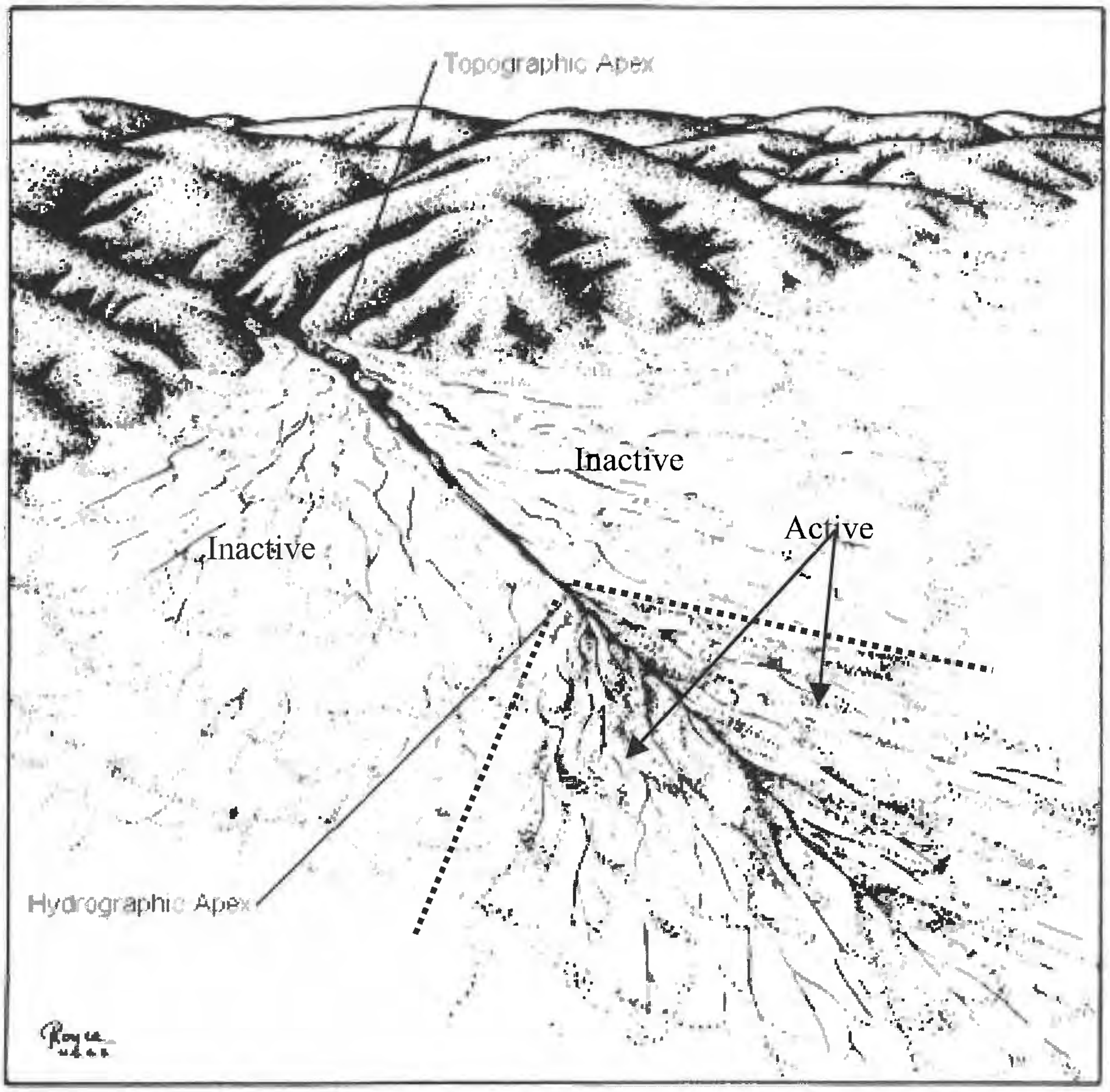


Figure G-1. Alluvial Fan With Entrenched Channel Leading To Active Deposition at Distal Part of the Fan. Original Published as Figure 3-2 in *Alluvial Fan Flooding* (National Research Council, 1996). Reproduced with Permission From the National Research Council; Annotations Added by FEMA.

G.2 Analysis Approach **[February 2002]**

Through the approach for alluvial fan flooding identification and mapping documented herein, FEMA seeks to identify whether (1) the area under study is an alluvial fan and (2) which portions of this area, if any, are characterized by or subject to active alluvial fan flooding. After these steps, various methods unique to different situations can be employed to analyze and define the 1-percent-annual-chance (100-year) flood within the areas of alluvial fan flooding identified on the alluvial fan. Thus, the approach for the identification and mapping of alluvial fan flooding can be divided into three stages.

- Stage 1—Recognizing and characterizing alluvial fan landforms;
- Stage 2—Defining the nature of the alluvial fan environment and identifying active and inactive areas of the fan; and
- Stage 3—Defining and characterizing the 1-percent-annual-chance (100-year) flood within the defined areas.

Each of these stages is described in detail in this Appendix. Additional information also can be found in a National Research Council report entitled *Alluvial Fan Flooding* (National Research Council, 1996).

Each stage must be addressed and thoroughly documented during the analysis process. Because each stage builds on the previous stage and because of the complexity of many alluvial fans, the Mapping Partner who undertakes the analysis and mapping of alluvial fan flooding must coordinate closely with the FEMA Regional Project Officer (RPO) and FEMA Headquarters (HQ) from the onset of the study. The progression of the process is shown in Figure G-2.

Progression through each of the stages results in a procedure that narrows or divides the problem to smaller and smaller areas. In Stage 1, the landform on which the flooding occurs must be characterized. If the location of study is an alluvial fan, the Mapping Partner proceeds to Stage 2 to identify which parts of the alluvial fan are active or inactive. Finally, in Stage 3, the Mapping Partner performing the analysis must use various methods to define and analyze the 1-percent-annual-chance (100-year) flood within each identified area of alluvial fan flooding. Progression through these stages requires a variety of maps and photographs, as well as a significant amount of field work and analysis to fully understand the flood hazard. The Mapping Partner may need to consult with geologists, geomorphologists, and/or soil scientists during each stage.

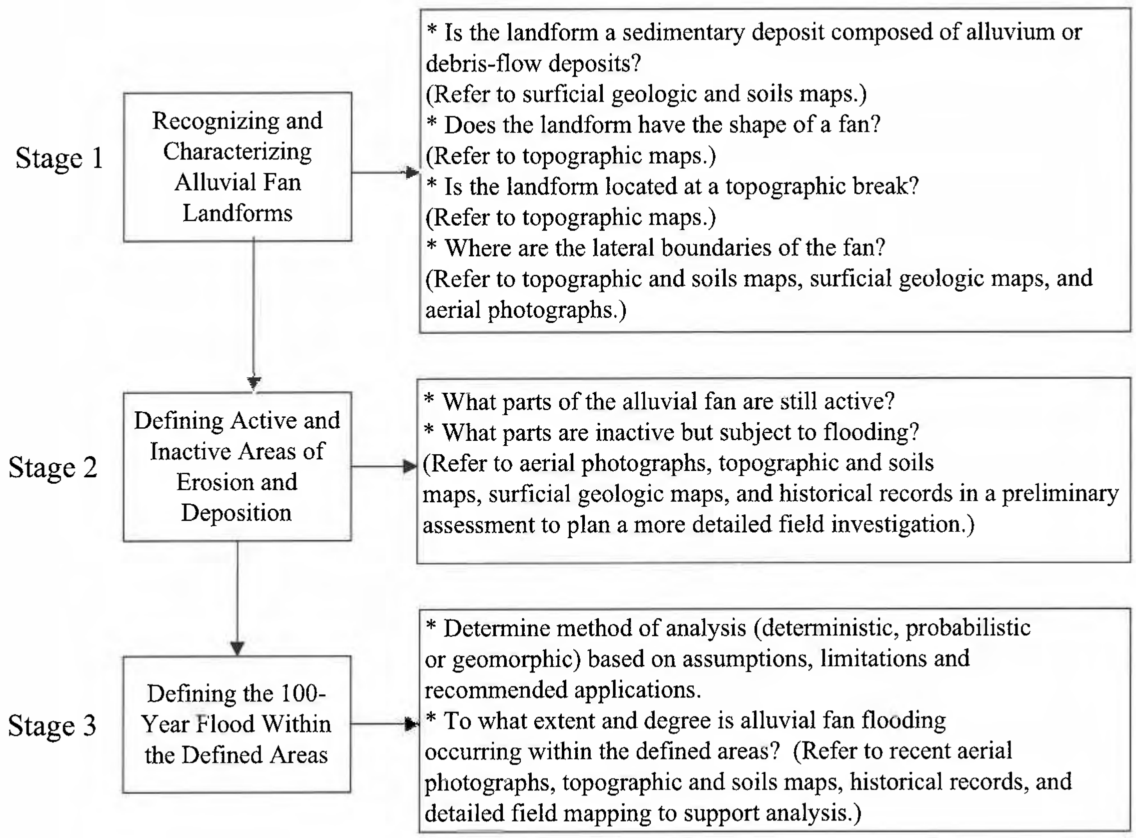


Figure G-2. Three Stages of the Process To Identify and Map Alluvial Fan Flooding. Original Published in National Research Council, 1996, Figure 3-1; Amended by FEMA.

G.2.1 Stage 1: Recognizing and Characterizing Alluvial Fan Landforms [February 2002]

As defined in this Appendix, alluvial fan flooding occurs only on alluvial fans. Therefore, the first stage of the process is to determine whether the landform in question is an alluvial fan. If, after following the guidelines in this subsection, the Mapping Partner concludes that the landform is not an alluvial fan, then the methods described in this Appendix are not intended for, or necessarily applicable to, the landform in question.

An alluvial fan is a sedimentary deposit located at a topographic break such as the base of a mountain front, escarpment, or valley side, that is composed of streamflow and/or debris flow sediments and has the shape of a fan, either fully or partially extended. These characteristics can be categorized by composition, morphology, and location as discussed in Subsections G.2.1.1, G.2.1.2, and G.2.1.3.

G.2.1.1 Composition [February 2002]

Alluvial fans are landforms constructed from deposits of alluvial sediments or debris flow materials. These deposits, "alluvium", are an accumulation of loose, unconsolidated to weakly consolidated sediments. Alluvium refers to sediments transported by either streamflow or debris flows. Geologic maps and field reconnaissance can be used to determine whether the landform is composed of alluvium.

G.2.1.2 Morphology [February 2002]

Alluvial fans are landforms that have the shape of a fan, either partly or fully extended. Flow paths may radiate outward to the perimeter of the fan; however, drainage may exhibit a range of patterns such as dendritic, anastomosing, and distributary. Topographic maps and aerial photos can be used to assess this criterion.

G.2.1.3 Location [February 2002]

Alluvial fan landforms are located at a topographic break where long-term channel migration and sediment accumulation become markedly less confined than upstream of the break. This locus of increased channel migration and sedimentation is referred to as the alluvial fan apex.

The topographic apex is at the extreme upstream extent of the alluvial fan landform. The hydrographic apex is the highest point on the alluvial fan where there exists physical evidence of channel bifurcation and/or significant flow outside the defined channel; its location may be either coincidental with, or at a point downstream of, the topographic apex as seen in Figure G-1. The hydrographic apex may depend on the discharge and may vary with the magnitude of the flooding event.

G.2.1.4 Defining Toe and Lateral Boundaries [February 2002]

The distal terminus, or ***toe***, of an alluvial fan commonly is defined by:

- A stream that intersects the fan and transports deposits away from the fan;
- A playa lake;
- An alluvial plain; and
- Smoother, gentler slopes of the piedmont plain.

Such boundaries can often be identified on topographic maps by changes in contour lines or identified on aerial photographs or by field inspection as changes in vegetation as a result of sediment changes or increased water table depth.

Lateral boundaries of alluvial fans are the edges of deposited and reworked alluvial materials. The lateral boundary of a single alluvial fan typically is a trough, channel, or swale formed at the lateral limits of deposition. The lateral boundary also may be a confining mountainside.

Lateral boundaries of single alluvial fans can often be identified as a contact of distinct differences between light-colored, freshly abraded, alluvial deposits and darker-colored, weathered deposits with well-developed soils on piedmont plains. Care should be taken to ensure that the contact is not simply a divide between older and more recent deposits of the alluvial fan.

The lateral boundaries of alluvial fans that coalesce with adjacent alluvial fans are generally less distinct than those of single alluvial fans. These lateral boundaries may be marked by a topographic trough or ridge. It is sometimes possible to distinguish between surfaces of adjacent alluvial fans based on different source-basin rock types. Defining the lateral boundaries of coalescing fans will likely require additional fieldwork, use of surficial geologic and soils maps, and consultation with a geomorphologist or soil scientist.

G.2.2 Stage 2: Defining Active and Inactive Areas [February 2002]

During Stage 1, the Mapping Partner conducting the analysis identified whether the landform in question is an alluvial fan. During Stage 2, the Mapping Partner will seek to delineate areas of the alluvial fan that are active or inactive in the deposition, erosion, and unstable flow path flooding that builds alluvial fans. The activities in Stage 2 have been designed to narrow the area of concern for Stage 3, which is the specific identification of the extent of the 1-percent-annual-chance (100-year) flood.

Although active alluvial fan flooding has occurred on all parts of an alluvial fan at some time in the geologic past in order to construct the landform itself, this does not mean that all parts are equally susceptible to active alluvial fan flooding now. Also, flooding may be occurring on inactive areas of the alluvial fan.

In most of the United States, it is possible to identify parts of alluvial fans that were actively constructed during the Pleistocene epoch (approximately 2 million to 10,000 years ago) and parts that have been active (i.e., flooded) during the Holocene epoch (the past 10,000 years). The reason that this broad distinction generally is possible is that the two epochs were identified and defined on the basis of climatic conditions.

The Holocene epoch is a time of interglacial warm conditions, whereas the Pleistocene epoch was marked by repeated full glacial, cool conditions alternating with warm interglacials like that of the Holocene epoch. As a result of these climatic differences, flooding and sedimentation occurred at different rates and magnitudes during the Pleistocene and Holocene epochs. The impacts of these climatic changes on alluvial fan formation can be inferred from geologic, geomorphic, and soil data.

A change in the rate of tectonic uplift along a mountain front can also result in abandonment of parts of alluvial fans. For example, a decrease in the rate of uplift at a mountain front relative to the alluvial fan could result in stream channel downcutting at the mountain front/alluvial fan apex over a period of time. As a consequence, the upper part of the fan would become entrenched, and the active area of deposition would shift downfan.

G.2.2.1 Identification of Active Areas [February 2002]

The term *active* refers to that portion of an alluvial fan where deposition, erosion, and unstable flow paths are possible. If flooding and deposition have occurred on a part of an alluvial fan in the past 100 years, clearly that part of the fan can be considered to be active.

Historic records, photographs, time-sequence aerial photography, and engineering and geomorphic information may support this conclusion. If flooding and deposition have occurred on a part of an alluvial fan in the past 1,000 years, for example, that part of the fan may be subject to future alluvial fan flooding.

This conclusion may only be supported by geomorphic information, however. It becomes more difficult to determine whether a part of the fan that has not experienced sedimentation for more than 1,000 years actually is active, that is, that there is some likelihood of flooding and sedimentation under the present climate conditions.

Because there is no clear analytical technique for making such projections of the estimates of the spatial extent of inundation, Stage 2 analysis involves systematically applied judgment and the combination of hydraulic computations and qualitative interpretations of geologic evidence concerning the recent history and probable future evolution of channel forms, as well as flooding and sedimentation processes. It must be kept in mind, however, that the intent of Stage 2 is to narrow the area of concern with regard to active deposition, erosion, and unstable flow paths over a period of time generally exceeding 100 years. Therefore, the combination of engineering and geomorphic analyses, both qualitative and quantitative, provide an indication of the approximate spatial extent of possible inundation over a relatively long time period (i.e., several thousand years). During Stage 3, the Mapping Partner that performs the detailed study shall determine the floodplain limits associated with the 1-percent-annual-chance (100-year) flood.

G.2.2.2 Identification of Inactive Areas [February 2002]

For a given area of the alluvial fan, if the situations described in Subsection G.2.2.1 do not exist, then the area is considered inactive and not subject to the deposition, erosion, and unstable flow path flooding that builds alluvial fans. Inactive areas may be subject to flooding though, most notably within entrenched channels.

Evidence of inactive areas may include armoring along the margin of the area bordering active areas, older vegetation, and the lack of change in flow paths viewed over the aerial photographic record. This evidence, though, does not preclude the area from possibly being classified as an active area as a result of changes in, or conditions within, adjacent active areas.

Older alluvial fan surfaces are considered active if any of the following are true:

- The recently active sedimentation zone is migrating into the older surface.
- The elevation difference between the recently active sedimentation zone and the older surface is small relative to flood, deposition, and debris depths conceivable in the current regime of climate, hydrology, or land use in the source area.
- Upstream of the site, there is an opportunity for avulsions that could lead channels or sheet floods across the older surface.

G.2.2.3 Identification Process [February 2002]

Once a relative time period is chosen (e.g., <1,000 years) to help evaluate the active areas of an alluvial fan, the analyst must determine relative ages for the morphologic features on the alluvial fan. Indicators of land surface age for Stage 2 are based on relative age indicators. Absolute (numerical) dating techniques, such as radiocarbon dating, are generally beyond the scope of many studies.

Detailed soils and surficial geological maps, when available, provide useful delineation of soil types and surface ages. An examination of the historical record of flooding and deposition can enhance the information gained from the soils map. Aerial photographs from different years can be used to identify sites of deposition. Field examination of morphologic features on the alluvial fan surface, particularly noting evidence of human activity (recent or archaeological) or weathering characteristics such as desert pavement, rock varnish, B-horizon development in the soil profile, calcic-horizon development, and pitting and rilling of clasts may also provide relative age information.

Density and type of vegetation can provide useful clues to the age of an alluvial fan surface area. Texture and composition of the sediment, in addition to the water-holding capacity, relate to the surface vegetation. Fresh alluvial deposits contain little organic carbon or clay and, as a result, do not promote vegetation growth. Vegetation is limited on older surfaces because they receive only direct rain, are often erosional, and can be less fertile (carbonate soil cropping out at the surface, for example). Intermediate-age surfaces (middle to late Holocene) contain the most dense and diverse vegetation. Use and interpretation of diagnostic vegetation, like the use and interpretation of desert pavement, varnish, or soil properties, are generally specific to the individual fan in question. Within a geographic region, however, surface characteristics of alluvial fans may be correlated from one fan to another.

Detailed topographic maps (i.e., 2-foot contour interval) are instrumental in identifying potential avulsion areas and in delineating the boundaries of areas subject to different flood, deposition and debris flow depths. Topographic maps also can be used to identify older alluvial surfaces within active zones that are not subject to flooding.

Areas of question noted during the analysis of maps and aerial photographs should be closely examined during the field inspection. All flow paths should be walked to verify the active and inactive areas that have been delineated. Stage 2 is complete when the analyst has defined and delineated all active and inactive areas of deposition, erosion, and unstable flow path flooding, as well as adjacent inactive fan areas. All inactive areas with stable flow path flooding and all active areas may be considered floodprone, but through Stage 2, the degree to which these areas are floodprone is not yet known. **The delineated floodprone areas of Stage 2 should approximate the largest possible extent of the 1-percent-annual-chance (100-year) flood.**

G.2.2.4 Types of Alluvial Fan Flooding [February 2002]

Several types of flooding occur on alluvial fans. The most common ones are flooding along stable channels, sheetflow, debris flow, and unstable flow path flooding.

Flooding Along Stable Channels

A deeply entrenched channel or network of channels often is subject to inactive alluvial fan flooding. This type of flooding usually occurs within distributary flow systems that were formed during climatic or tectonic conditions different from the present. This flooding can occur at the head of the alluvial fan but become unstable downstream. Conversely, unstable channels can become stable in the downstream direction; this can occur because of headcutting into the toe as a result of changing hydraulic conditions downstream from the toe. Human intervention, directly by channel modification or indirectly by land-use change, can create stable channels.

Sheetflow

Some parts of alluvial fans are characterized by sheetflow, which is the flow of water as broad sheets that are completely unconfined by any channel boundaries. Sheetflow might occur where flow departs from a confined channel and no new channel is formed. It might also occur where several shallow, distributary channels join together near the toe of a fan and the gradient of the fan is so low that the flows merge into a broad sheet. Because such sheetflows can carry high concentrations of sediment in shallow water and follow unpredictable flow paths, they are classified as active alluvial fan flooding.

Sheetflows generally occur on downslope parts of fans, where channel depths are low and the boundaries of channels become indiscernible. They are also more common at distal locations because of the likelihood of fine-grained sediments and shallow groundwater; during prolonged rainfall, the ground can become saturated, resulting in extensive sheet flooding as runoff arrives from upslope. Fine-grained sediments can aggravate the likelihood of sheetflow because some clay minerals swell when wet, forming an impermeable surface at the beginning of a rainstorm.

Debris Flow

Some parts of alluvial fans are characterized by debris flows, flows with a very high concentration of sediment in relation to water. Debris flows pose hazards that are very different from those of sheetflows or water flows in channels. Identifying those parts of alluvial fans where debris flow deposition might occur requires the examination of deposits from past flows. Debris flow deposits can be distinguished from fluvial deposits by differences in morphology, depositional relief, stratigraphy, and clast fabric. Exposures in channel banks can be examined and can be supplemented with shallow trenches in different deposits.

Unstable Flow Path Flooding

Active areas of an alluvial fan will generally be characterized by unstable and uncertain flow path flooding. This type of flooding usually creates a single channel just below the apex, but splits into multiple channels as it proceeds down the alluvial fan. These channels are subject to deposition and bank or bottom erosion that cause channel migration, avulsion, and the formation of new channels. Areas subject to this type of flooding are characterized by shallow, braided or distributary, sand- to gravel-bed channels. Recently formed channels may have less established vegetation, such as trees, than older channels in the same general area.

G.2.3 Stage 3: Defining the 100-Year Flood Within Defined Areas [February 2002]

FEMA uses the 100-year flood, the flood having a 1-percent chance of being exceeded in any given year, to delineate Special Flood Hazard Areas (SFHAs) on NFIP maps. In the preceding discussion of Stages 1 and 2, methods of identifying alluvial fan landforms and areas of active and inactive deposition, erosion, and unstable flow path flooding were described. During Stage 3, the Mapping Partner that performs the detailed study will determine the severity and will delineate the extent of the 1-percent-annual-chance (100-year) flood within any floodprone area identified during Stage 2.

The broad spectrum of alluvial fan landforms and types of flooding illustrates, as previously discussed, the futility of developing a "cookbook" method to apply to all fans in all geographic areas. The analysis of the flood hazards on alluvial fans therefore requires a flexible approach that is based on site-specific evaluations. Several methods for quantifying the 1-percent-annual-chance (100-year) flood are presented in the following sections and are summarized in Table G-1. Not all methods are appropriate for all situations. The assumptions and limitations of each should be carefully considered in deciding which methods to apply to particular areas of an alluvial fan.

Sample maps resulting from the application of some of the available methods are included as Figures G-5 through G-13.

G.2.3.1 Risk-Based Analysis [February 2002]

The U.S Army Corps of Engineers provided a framework that may be used to analyze flood hazards on alluvial fans using the principles of risk-based analysis in *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning* (U.S Army Corps of Engineers, 1992). This method uses the total probability equation that will be discussed in detail in Subsection G.2.3.2. The degree of uncertainty associated with a prediction of a given flood scenario is assessed by bringing to bear evidence derived from geomorphologic and other studies. This method tracks the effects of the error associated with a calculation to provide a confidence band in ensuing predictions of flood-hazard severity.

Table G-1. Methods for Defining the 1-Percent-Annual Chance (100-Year) Flood Within Floodprone Areas Defined During Stage 2

METHOD	ASSUMPTIONS	LIMITATIONS	RECOMMENDED APPLICATIONS	FIGURE NUMBE R
Risk-Based Analysis	Refer to *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning* (USACE, 1992).			
FAN Computer Program	Flooding in rectangular channel; critical depth, erosion of rectangular channel banks until the change in width divided by the change in depth equals –200; the probability density function of a discharge occurring at the apex is log-Pearson Type III; the frequency of flood events for various recurrence intervals, i.e., 2-year through 500-year, can be adequately defined; equal probability along contour arcs (random flow paths); (also provides for multiple channels at normal depth, assuming total width is 3.8 times the single-channel width)	Fluvial (as opposed to debris flow) formed fan, unstable flow paths	Highly active, conical fans	G-5
Sheetflow	Broad, unconfined, shallow flooding	Not for use in areas of undulating terrain	Shallow flooding across uniformly sloping surfaces	G-6
Hydraulic Analytical Methods	Stable flow path, uncertainty is to a degree that may be disregarded	Not for use with active alluvial fan flooding	Entrenched stable channel networks, constructed channels, urbanized areas	G-7 and G-13
Geomorphic Data, Post-Flood Hazard Verification, and Historical Information	Relies primarily on qualitative information, post-flood verification, historical data, and interpretive studies	Approximate method	Alluvial fans with little or no urbanization	G-8 and G-9
Composite Methods	As identified in the sections referring to the methods being applied	Must integrate multiple methods into one result	Floodprone areas that contain unique physical features in some locations or have areas varying in levels of erosion and migration activity	G-10, G-11, and G-12

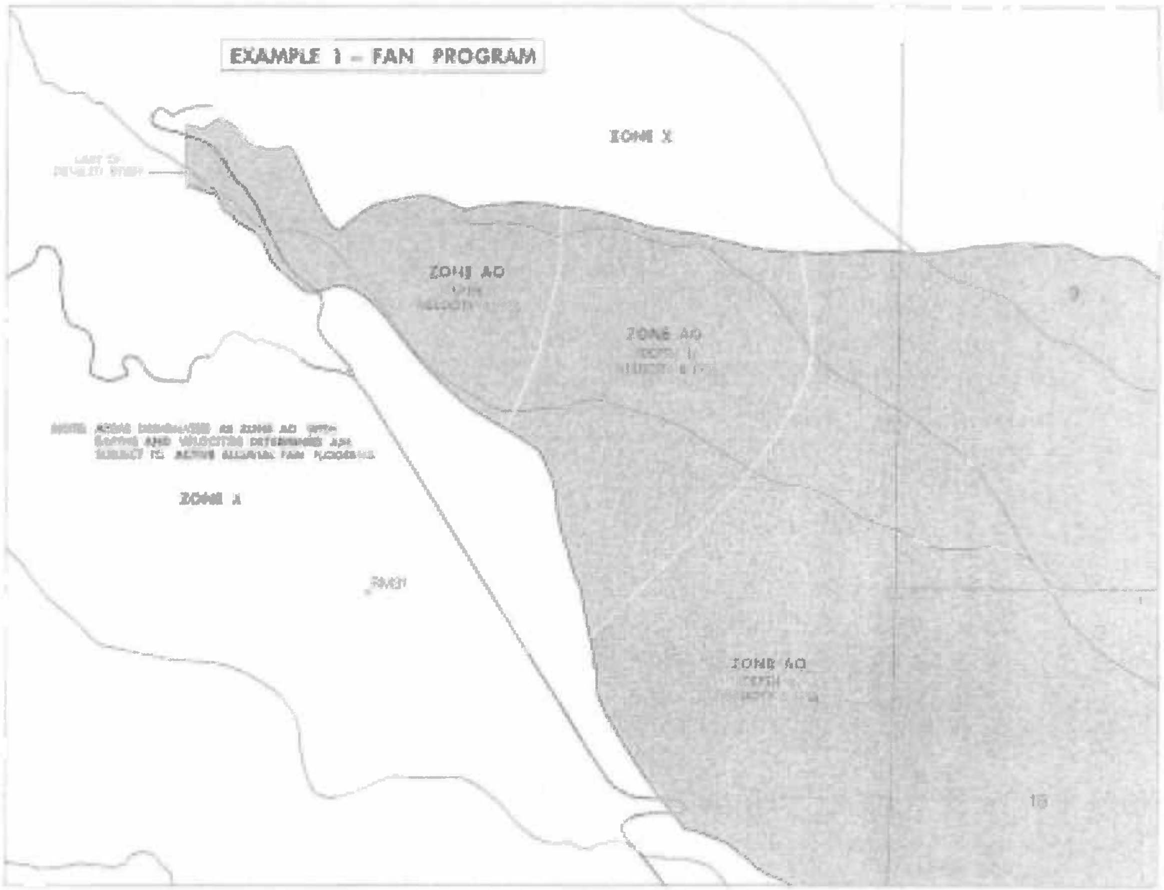


Figure G-5. Sample Map Generated From Alluvial Fan Analysis Using FAN Computer Program. This map appeared as Example 1 in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 2000).

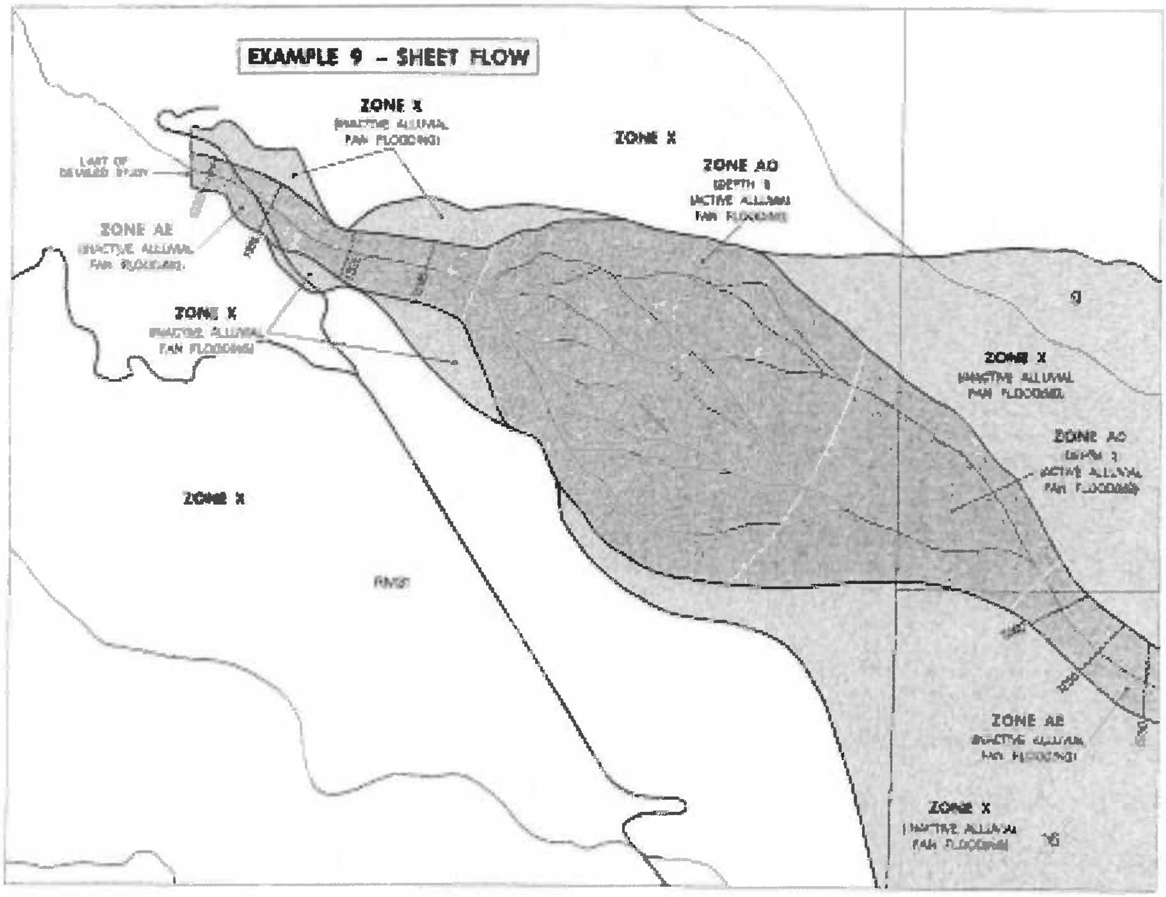


Figure G-6. Sample Map Generated From Alluvial Fan Analysis Using Sheetflow Analysis Methods. This map appeared as Example 9 in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 2000).

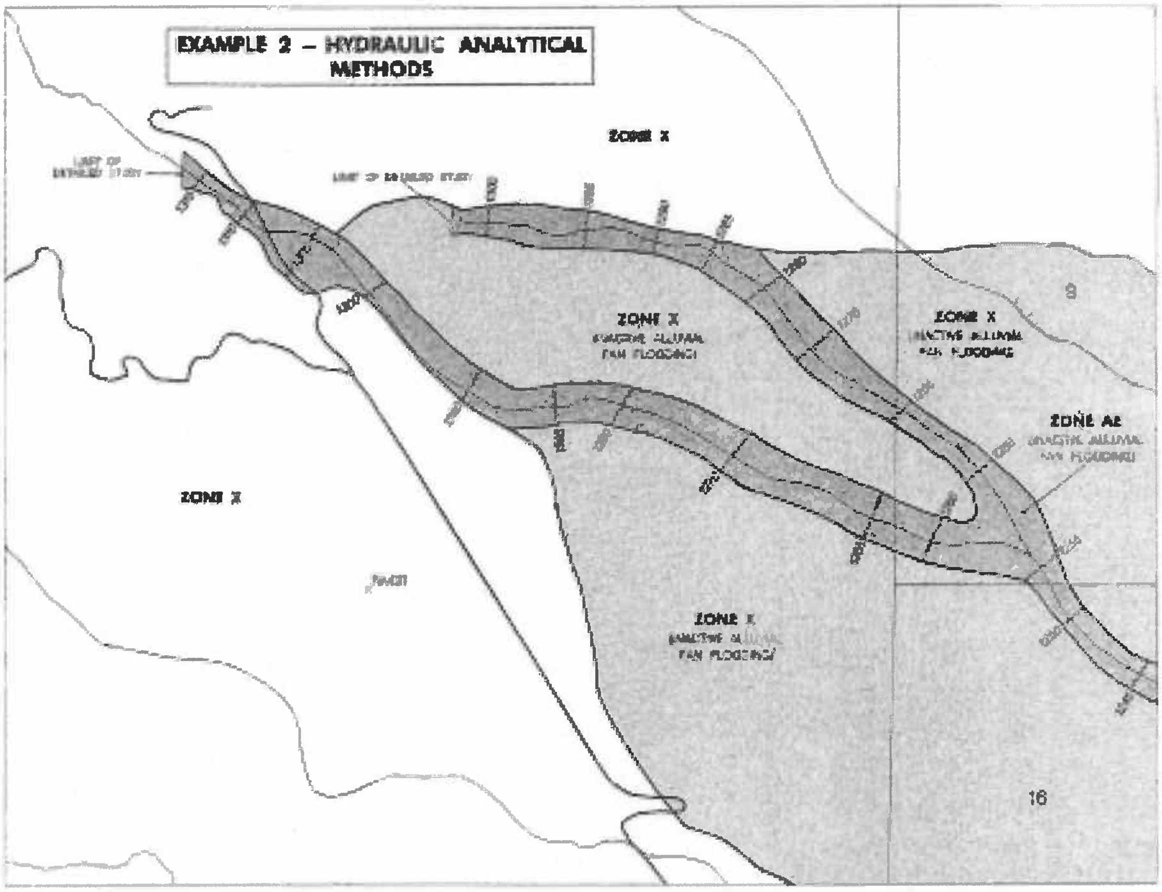


Figure G-7. Sample Map Generated From Alluvial Fan Analysis Using Hydraulic Analytical Methods. This map appeared as Example 2 in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 2000).

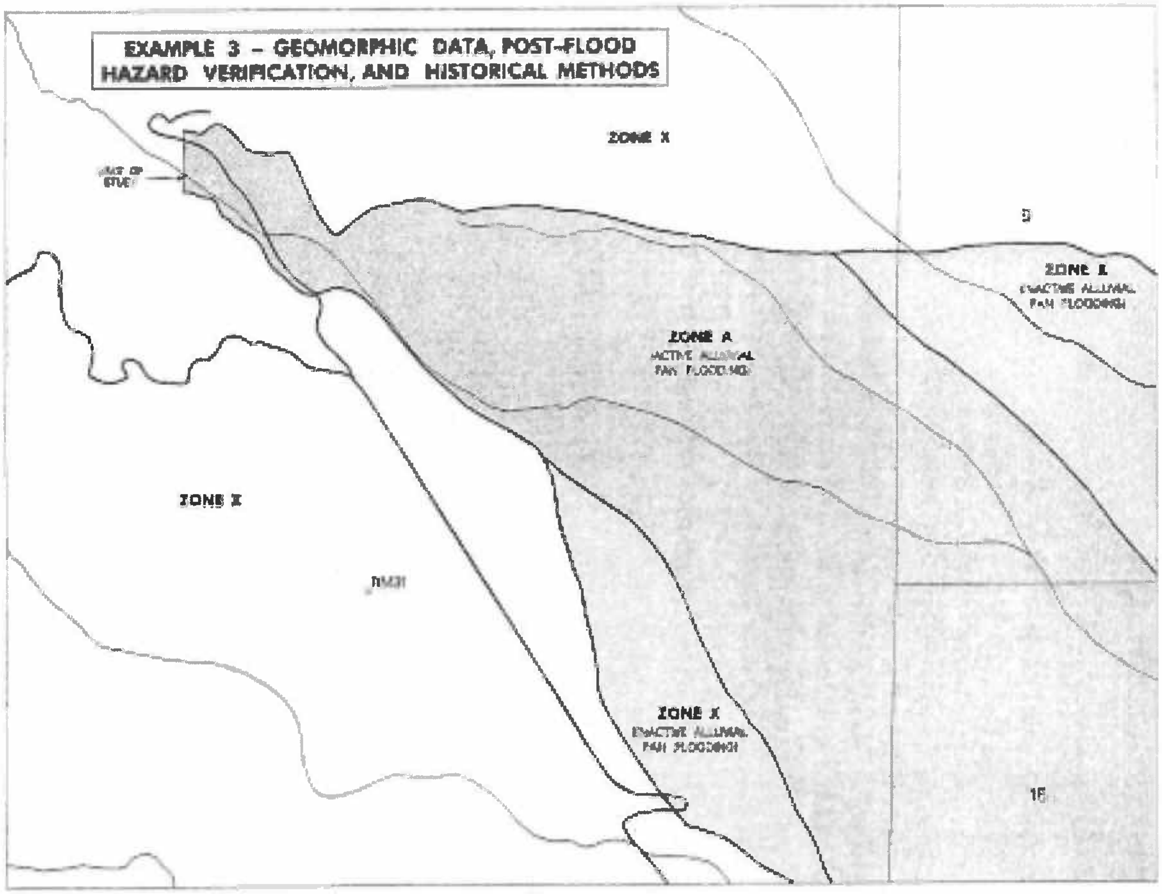


Figure G-8. Sample Map Generated From Alluvial Fan Analysis Using Geomorphic Data, Post-Flood Hazard Verification Data, and Historic Information. This map appeared as Example 3 in *Guidelines for Determining Flood Hazards on Alluvial Fan s* (FEMA, 2000).

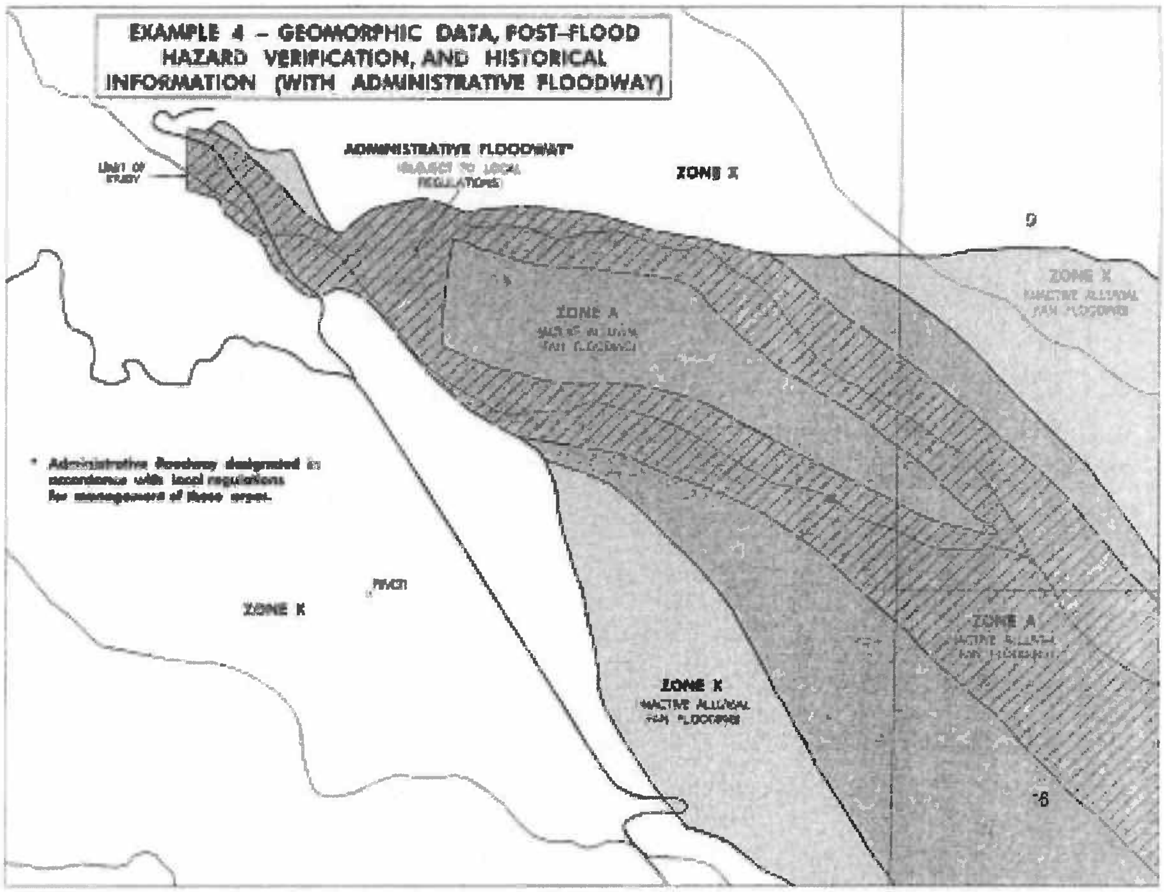


Figure G-9. Sample Map Generated From Alluvial Fan Analysis Using Geomorphic Data, Post-Flood Hazard Verification, and Historic Information (Administrative Floodway Shown). This map appeared as Example 4 in *Guidelines for Determining Flood Hazards Alluvial Fans* (FEMA, 2000).

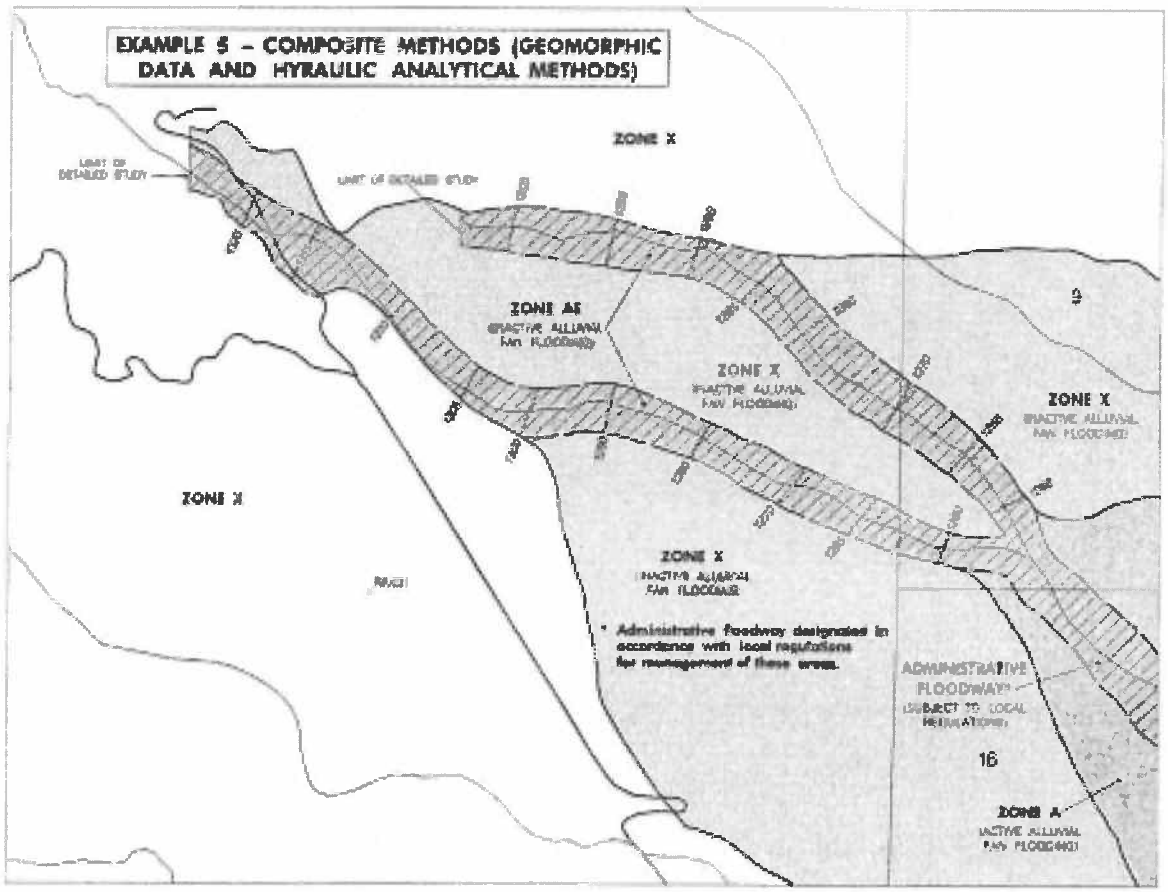


Figure G-10. Sample Map Generated From Alluvial Fan Analysis Using Composite Methods (Geomorphic Data and Hydraulic Analytical Methods). This map appeared as Example 5 in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 2000).

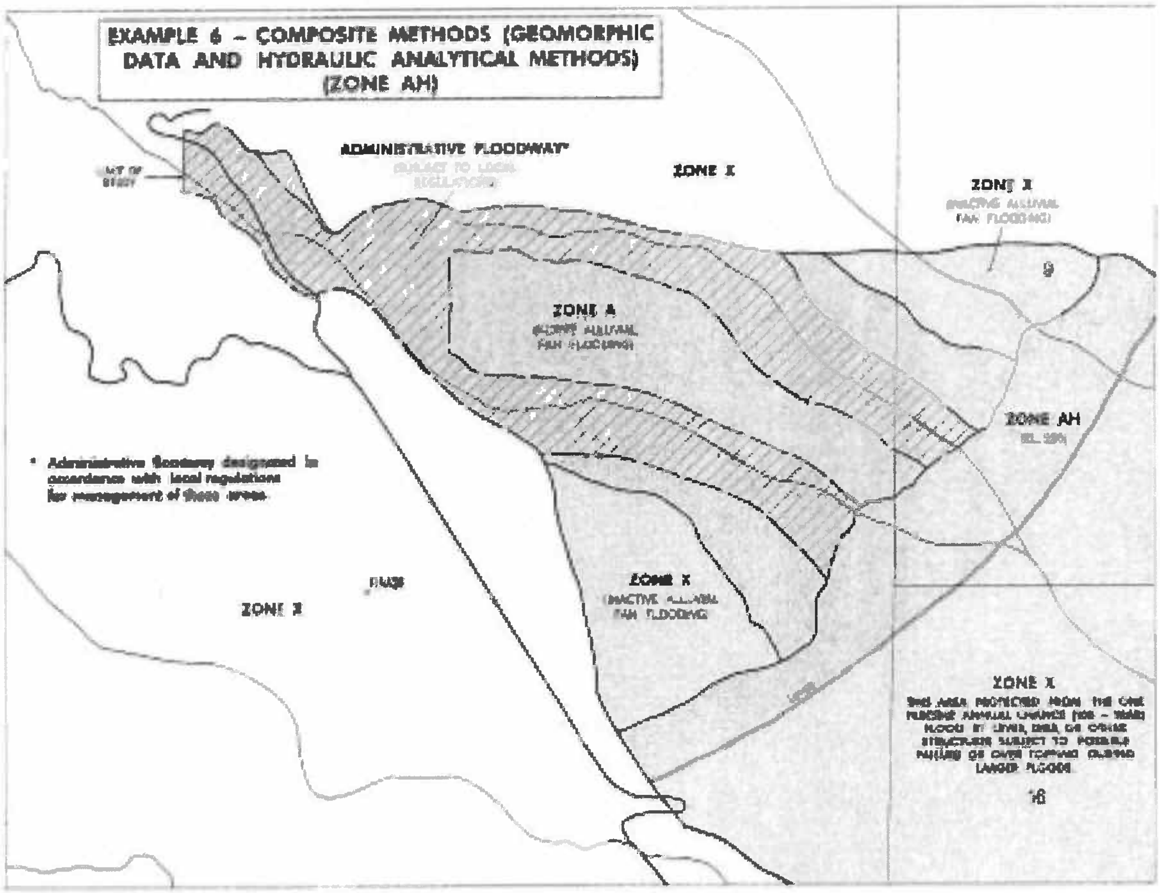


Figure G-11. Sample Map Generated From Alluvial Fan Analysis Using Composite Methods (Geomorphic Data and Hydraulic Analytical Methods); Zone AH Shown. This map appeared as Example 6 in *Guidelines for Determining Flood Hazards on Alluvial Fan s* (FEMA, 2000).

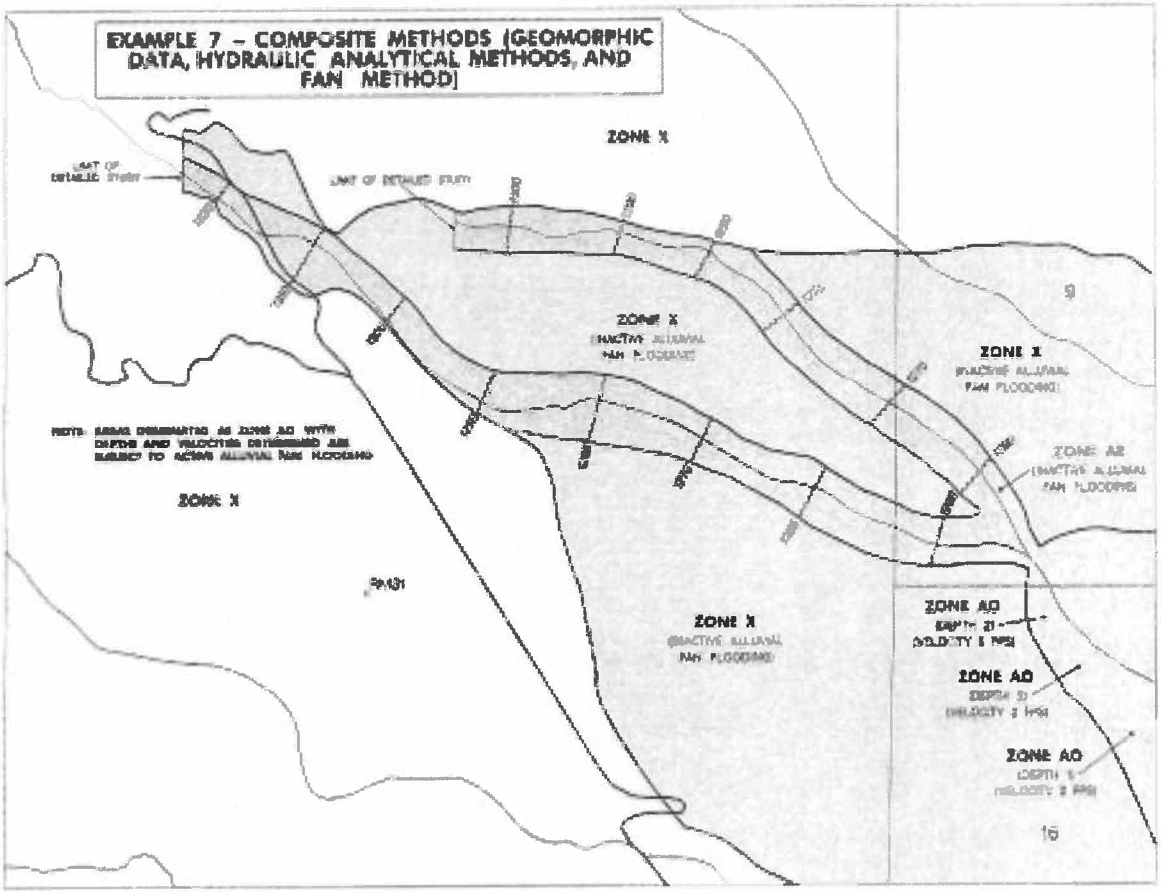


Figure G-12. Sample Map Generated From Analysis Using Composite Methods (Geomorphic Data, Hydraulic Analytical Methods, and FAN Computer Program). This map appeared as Example 7 in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 2000).

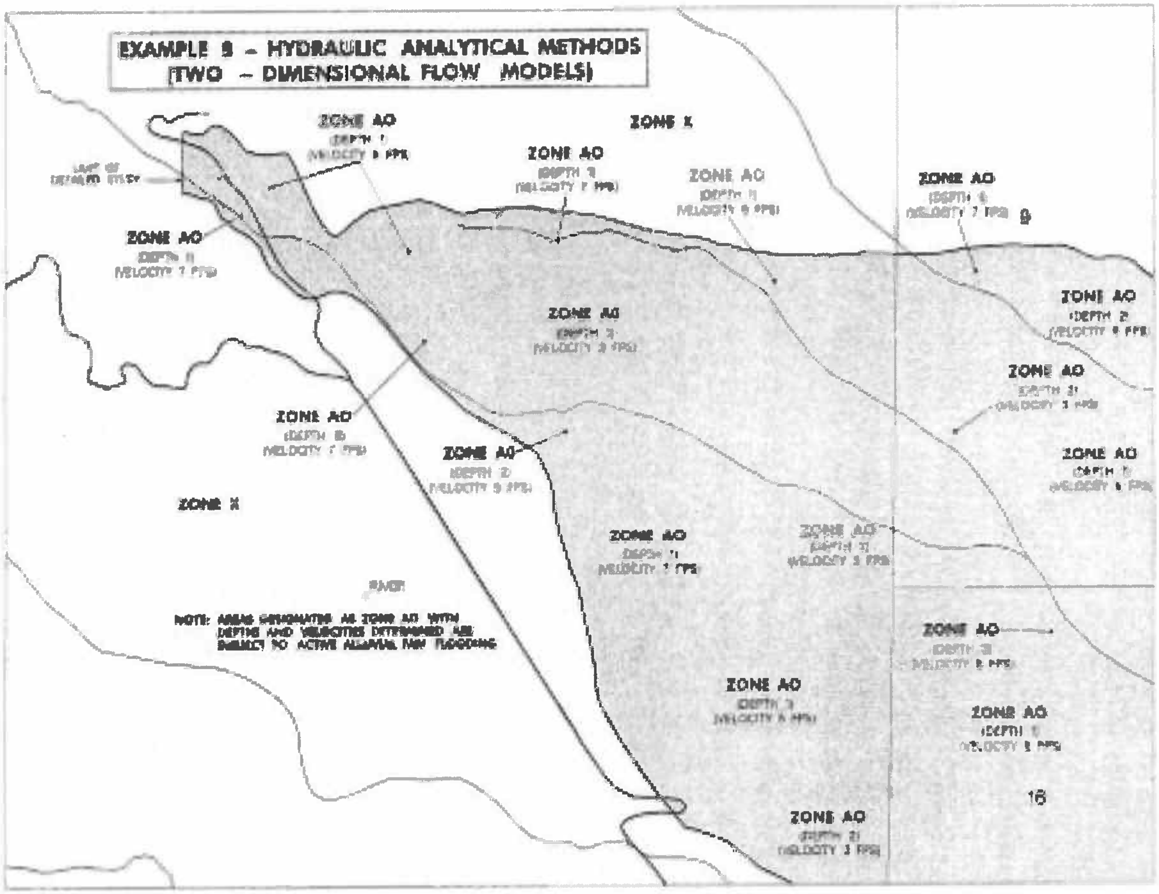


Figure G-13. Sample Map Generated From Alluvial Fan Analysis Using Hydraulic Analytical Methods (Two-Dimensional Flow Model). This map appeared as Example 8 in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 2000).

G.2.3.2 Analysis Using FAN Computer Program [February 2002]

Assumptions, limitations, and recommended applications for the FAN Computer program are as follows:

- Assumptions: flooding in rectangular channel; critical depth; erosion of rectangular channel banks until the change in width divided by the change in depth equals -200; the probability density function of a discharge occurring at the apex is log-Pearson Type III; the frequency of flood events for various recurrence intervals, i.e., 2-year through 500-year, can be adequately defined; equal probability along contour arcs (random flow paths); also provides for multiple channels at normal depth, assuming total width is 3.8 times the single channel width

- Limitations: fluvial (as opposed to debris flow) formed fan, unstable flow paths

- Recommended Applications: highly active, conical fans

The FAN computer program provides one method of analyzing the flood hazards on alluvial fans. The methodology used by the FAN program defines the risk of inundation at any particular location by applying the definition of the 1-percent-annual-chance (100-year) flood through the theorem of total probability. The methodology itself is broader than the use within the FAN program. Let **H** be a random variable denoting the occurrence of flooding at a particular location. That is:

$$\mathbf{H} = \begin{cases} 1 \text{ if the location is inundated} \\ 0 \text{ if the location is not inundated} \end{cases}$$

Then the probability of the location being inundated by a flood above a given magnitude, say q_0, is:

$$P\left[\boldsymbol{H} = 1 \bigcap \boldsymbol{Q} > q_0\right] = \int_{q_0}^{\infty} P_{H|Q}(1,q) f_Q(q)dq \qquad (1)$$

where

$\boldsymbol{Q}$ = random variable denoting the magnitude of the flood

$P_{H|Q}(1,q)$ = conditional probability that the location will be inundated, given that a flood of magnitude q is occurring

$f_Q(q)$ = probability density function (PDF) defining the likelihood that a flood of a magnitude between q and q+dq will occur in any given year

The FAN computer program provides one method of analyzing the flood hazards on alluvial fans. The methodology used by the FAN program defines the risk of inundation at any particular location by applying the definition of the 1-percent-annual-chance (100-year) flood through the theorem of total probability. The methodology itself is broader than the use within the FAN program. Let **H** be a random variable denoting the occurrence of flooding at a particular location. That is:

$$\mathbf{H} = \begin{cases} 1 & \text{if the location is inundated} \\ 0 & \text{if the location is not inundated} \end{cases}$$

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$$P\left[\boldsymbol{H} = 1 \bigcap \boldsymbol{Q} > q_0\right] = \int_{q_0}^{\infty} P_{H|Q}(1,q) f_Q(q) dq \qquad (1)$$

where

$\boldsymbol{Q}$ = random variable denoting the magnitude of the flood

$P_{H|Q}(1,q)$ = conditional probability that the location will be inundated, given that a flood of magnitude q is occurring

$f_Q(q)$ = probability density function (PDF) defining the likelihood that a flood of a magnitude between q and q+dq will occur in any given year

Equation (1) only defines whether a location is within an SFHA and does so in terms of the parameter q_0. For riverine flooding, q_0 represents an elevation, and $P_{H|Q}(1,q)$ is 1 if the elevation of the location is less than q_0 and 0 if it is greater than q_0. At a given location (point on a cross section), there is a one-to-one relationship between the discharge being conveyed by the stream and the elevation of the surface of the floodwater (i.e., the rating curve for the cross section). For riverine flooding, solving Equation (1) reduces to defining the discharge-frequency relationship for the reach of the stream under consideration (hence the notation q_0 to denote magnitude).

As in riverine analysis, the PDF describing frequency of the magnitude of flooding for alluvial fan flooding is taken to be the discharge-frequency relationship of the contributing drainage basin. Unlike riverine analysis, $P_{H|Q}(1,q)$ does not simplify to 0 or 1, because there is uncertainty in the flow path. The FAN program provides energy depths and velocities relating to discharge for use in defining the flood hazard.

The FAN program uses the assumptions outlined below. Where noted with an asterisk (*), these assumptions may be adjusted for observed field conditions; however, the FAN program does not readily accommodate these adjustments.

This method's assumptions are as follows. Floods on alluvial fans are at liberty to expend energy to create the most efficient path to convey the water and sediment load. That path is shallow and approximately rectangular in cross section. Energy is expended through sediment movement until the minimum energy possible is reached. In short, the reasoning is that a flood flows at critical depth and is confined to a rectangular path. The flow path would not widen indefinitely but, instead, would reach a point where it would stabilize. From empirical data, of which there are very little, that point is taken to be where the rate of change of topwidth per change in depth (dW/dd) is –200 (* may be adjusted).

The reasoning leads to the one-to-one relationships:

$$d = 0.106\ q^{1/5} \qquad (2)$$

$$v = 1.506\ q^{1/5} \qquad (3)$$

where

d = specific energy in feet

v = velocity in feet per second

q = discharge in cubic feet per second (cfs)

The conditional probability in Equation (1) accounts for the uncertainty in the path of a flood with a given magnitude. Even if the path of the flood can be predicted with reasonable certainty, the magnitude of the flood at a particular location may not be so certain, as deposition or scour in shallow channels may greatly affect the direction of flow at channel splits. Many alluvial fans exhibit a channel network. The capacities of the individual channels as well as the capacities of the networks in aggregate vary from almost negligible to more than the 1-percent-annual-chance (100-year) flood discharge. The treatment of the uncertainty in a given discharge being exceeded at a particular location given the discharge somewhere else [$P_{H|Q}(1,q)$] varies.

The least complex treatment (used in the FAN program) follows from the reasoning that the topography of the area is the result of deposition that occurred during the past. If that process continues, then, over the long term, the probability of every point on a contour being inundated is the same. That is, $P_{H|Q}(1,q)$ is uniformly distributed and, for a given point, is approximately the width of the flood path divided by the width (the "contour width") of the area subject to flooding at the elevation of that point (* may be adjusted). This method assumes that all areas of the alluvial fan are subject to flooding and that there is a fixed relationship between flooding depth and discharge.

In general, these assumptions apply when there is absolute uncertainty regarding how floods will occur. Thus, for the FAN program, under the simple conditions,

$$P_{H|Q}(1,q) = \frac{w(q)}{W_{fan}} = \frac{9.408\, q^{2/5}}{W_{fan}} \qquad (4)$$

where

$w(q)$ = width of the path conveying q cfs

W_{fan} = contour width

The contour width, W_{fan} , is shown in Figure G-3. The resulting flood insurance risk zones are depicted in Figure G-4. The functional form of Equation (4) is a consequence of the reasoning leading to Equations (2) and (3) and is presented here for demonstrative purposes, not as the only form possible.

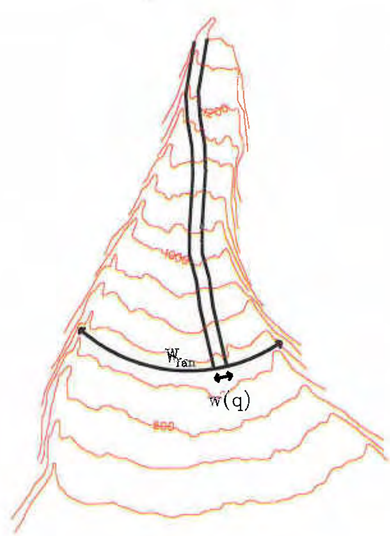

Figure G-3. Fan and Single-Channel Widths

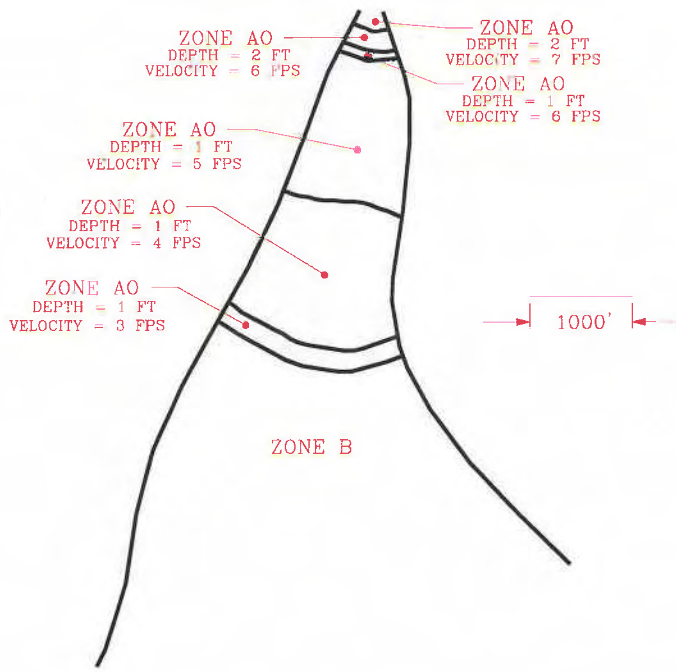

Figure G-4. Flood Insurance Risk Zones Respective to Figure G-3

The FAN program provides for the situation where flows are near normal depth in multiple channels. Program output includes results for this situation in addition to the single channel at critical depth. The results are then applied based on observed field conditions. More information is provided in *FAN: An Alluvial Fan Flooding Computer Program User's Manual and Program Disk* (FEMA, 1990). The FAN program is available online through the FEMA Flood Hazard Mapping Web site at http://www.fema.gov/fhm/dl_fnprg.shtm.

G.2.3.3 Sheetflow Analysis Method [February 2002]

Assumptions, limitations, and recommended applications for the sheetflow analysis method are as follows:

- Assumptions: broad, unconfined, shallow flooding
- Limitations: not for use in areas of undulating terrain
- Recommended Applications: shallow flooding across uniformly sloping surfaces

Guidance on the analysis and mapping of shallow flooding is provided in Appendix E of these Guidelines. Although Appendix E indicates that Mapping Partners are not to use the procedures in that Appendix for the analysis of alluvial fan flooding, the approach established by this Appendix enables the use of those methods described in Appendix E, except for highly active conical fans that are studied using the FAN program.

G.2.3.4 Hydraulic Analytical Methods [February 2002]

Assumptions, limitations, and recommended applications for hydraulic analytical methods are as follows:

- Assumptions: stable flow path, uncertainty is to a degree that may be disregarded
- Limitations: not for use with active alluvial fan flooding
- Recommended Applications: entrenched stable channels and channel networks, constructed channels, urbanized areas

For inactive, yet floodprone areas, the Mapping Partner that performs the alluvial fan analysis may use "riverine" hydraulic analytical methods. Where flow paths are stable and flow is reasonably confined, standard hydraulic engineering methods, such as backwater computations, may be used to define the elevation (or depth), velocity, and extent of the 1-percent-annual-chance (100-year) flood. Hydraulic methods may also be used for stable channel networks when applicable. For example, relict alluvial fans or inactive fans with stable channels, as determined by a geomorphic analysis, may be subject to flow splits throughout the distributary system that exists. Hydraulic modeling can generally handle split-flow analyses through stream junctions of this type.

In general, for stable channels on alluvial fans, physically based methods that consider site processes and hydraulics, such as channel geometry, grade and roughness, and channel bank and bed material are preferred. Where precise computations of water-surface profiles using energy and momentum based methods may not be feasible based on the scope of the study, the use of normal depth calculations for definition of approximate floodplain boundaries for the 1-percent-annual-chance (100-year) flood may be warranted.

Appendix C of these Guidelines provides guidance for hydraulic analytical methods. Several methods applicable to conditions found on alluvial fans are described. These methods include two-dimensional water-surface models, modeling techniques of streams with supercritical flow regimes, and split-flow analysis.

Two-dimensional models may be appropriate for determining flood hazards on an alluvial fan. Different two-dimensional models may be particularly useful in the analysis and modeling of some or all of the following situations: flows that contain a high amount of sediment, unconfined flows, split flows, mud/debris flows, and complex urban flooding. For use in defining flood hazards for the NFIP, all hydraulic models must meet the conditions of Paragraph 65.6 (a) (6) of the NFIP regulations.

One-dimensional sediment transport models or the methods described in Section G.3 are also useful for the analysis of conditions on alluvial fans.

G.2.3.5 Analysis Using Geomorphic Data, Post-Flood Hazard Verification, and Historical Information [February 2002]

Assumptions, limitations, and recommended applications for alluvial fan flooding analyses performed using geomorphic, post-flood hazard verification, and historical information are as follows:

- Assumptions: relies primarily on qualitative information, post-flood hazard verification, historical data, and interpretive studies
- Limitations: approximate method
- Recommended Applications: alluvial fans with little or no urbanization

The geomorphic approach is for active alluvial fans where deposition, erosion, and unstable flow paths are possible. Traditional engineering methods, as described in Subsection G.2.3.4, generally are inappropriate for areas with these hydraulic characteristics. Probabilistic methods, as described in Subsection G.2.3.2 and contained in the FAN computer program, also contain inherent limiting assumptions that may not adequately represent field conditions and may not be applicable to many active alluvial fans.

In some situations, the Mapping Partner may use the information collected during Stage 2 to delineate an approximate floodplain on an alluvial fan. In situations where geomorphic field investigations, coupled with historical documentation, and documentation of hydrologic and hydraulic characteristics of flood event(s) (post-flood hazard verification) are available, an approximate flood hazard delineation is possible.

By combining quantitative data on an actual flood event, historical information and photographs of other flood events, time-sequence aerial photography documenting recent activity or inactivity, and field investigation of the morphologic characteristics and relative ages of the fan, an approximate (Zone A) flood hazard delineation may be warranted.

For many alluvial fans, the various flood indicators (Stage 2 information) provide limited or partial information. Because the flood assessment of active alluvial fans is more uncertain than more traditional flood assessment, the Mapping Partner that perform the analysis must document all assumptions and limitations well and consider these assumptions and limitations in the overall evaluation.

G.2.3.6 Analysis Using Composite Methods [February 2002]

Assumptions, limitations, and recommended applications for alluvial fan flooding analyses performed using composite methods are as follows:

- Assumptions: as identified in the sections referring to the methods being applied
- Limitations: must integrate multiple methods into one result
- Recommended Applications: floodprone areas that contain unique physical features in some locations or have areas varying in levels of erosion and migration activity

Site-specific conditions on alluvial fans may lend themselves to the use of multiple or combined methods previously described for the determination of flood hazards. For example, in areas that contain manmade conveyance channels or deeply entrenched stable channels, the Mapping Partner can combine the results of traditional hydraulic computer programs with methods for analyzing active areas. The Mapping Partner that performs the analysis must coordinate with the FEMA RPO and with FEMA HQ staff during the development of the study plan.

Thank you for your comment, Anne Alexander.

The comment tracking number that has been assigned to your comment is SolarD11904.

Comment Date: May 3, 2011 02:12:03AM
Solar Energy Development PEIS
Comment ID: SolarD11904

First Name: Anne
Middle Initial:
Last Name: Alexander
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Zip: 90067
Country: USA
Privacy Preference: Don't withhold name or address from public record
Attachment: BNSF Comments to Draft Solar PEIS Part 3.pdf

Comment Submitted:

G.3 Additional Information on Sediment Transport

[February 2002]

This section regarding sediment transport is included as supplemental information for the analysis of alluvial fans. Sediment transport analyses are generally required for alluvial fan studies and revisions.

The boundaries of the stream channel are usually soil material with a given resistance to erosion. Bed material can range from large boulders to very fine clay particles. In general terms, sediment can be cohesive, including clay, silt, and mixtures, or noncohesive, including sand, gravel, and larger particles. Transport of noncohesive materials is strongly dependent on particle size. The entire size distribution of the material is needed to ascertain its erodibility. The bond between particles in cohesive soil dictates its resistance to erosion and is far more important than size distribution. However, size becomes important once the material has been eroded and is transported by the flow.

An important sediment transport process is the development of an armor layer in beds containing gravel and cobbles. Water flowing over the mixture of sand and coarser material lifts the smaller grains and leaves an upper layer or armor of large particles. This armor protects the underlying sediment from further erosion and controls the subsequent behavior of sediment transport. A flood event of large magnitude can disturb the protective layer, and the armoring process will start again.

Sediment transport exerts substantial control over morphology and channel geometric configuration. An indicator of this influence is the sediment transport rate, which is the rate at which material moves in the stream as quantified in units of weight per unit time. The transport rate is closely dependent on the water discharge.

Two classification systems are used describe the sediment load in a stream. The first classification system divides the load into ***bed load*** and ***suspended load***. The ***bed load*** is that portion of the sediment that moves along the bottom by sliding, rolling, or saltation. The ***suspended load*** is comprised of all of the material carried in suspension.

The second classification system divides the sediment load into ***wash load*** and ***bed-material load***. The ***wash load*** is comprised of very fine materials, clay and silt, rarely found in the bed. The wash load does not depend on the carrying capacity of the stream but on the amount supplied by the watershed. The ***bed-material load*** is comprised of all of the material found in the bed. Some of it will move very close to the bottom, but some may be found in suspension.

Quantification of sediment transport is fraught with uncertainty because of the complexity of the phenomenon and its inherent spatial and temporal variability. Existing mathematical representations have relied heavily on experimental results.

The available sediment transport formulas have been grouped according to the approach used to derive them. Three major approaches have been used: shear stress, power, and parametric. Formulas also can be grouped according to the component of the total load they attempt to quantify: bed load, suspended load, or bed-material load. Table G-2 summarizes some of the more commonly used formulas; however, it is not intended to be a complete listing.

Table G-2. Sediment Transport Formulas and Classifications

		Sediment Transport Formula										
Criteria	**Grouping**	**DuBoys (1879)**	**Shields (1936)**	**Einstein Bed Load(1950)**	**Einstein Suspended Load (1950)**	**Meyer-Peter-Muller (1948)**	**Einstein-Brown (1950)**	**Parker *et al.* (1982)**	**Engelund-Hansen (1967)**	**Ackers-White (1973)**	**Yang (1972)**	**Colby (1964)**
Approach	Shear Stress	x	x	x		x	x	x				
	Power								x	x	x	
	Parametric											x
Load Component	Bed Load	x	x	x		x	x	x				
	Suspended Load				x							
	Bed-Material Load								x	x	x	x

Despite the intense efforts expended in the development of these formulas, evaluation against field data indicates that they commonly overpredict or underpredict sediment loads by orders of magnitude of actual measured sediment transport rates. This discrepancy is likely a result of imperfect knowledge of the physics of sediment transport and also of the extensive variability and heterogeneity in hydrologic and geologic factors.

For these reasons, no one formula is better than the others. Mapping Partners, who must have sufficient field experience to make decisions regarding the method to use and how to map the results obtained using that method, must select a sediment transport formula based on how well the conditions of the problem at hand match the assumptions underlying the formula. If possible, Mapping Partners should verify the applicability of the formula with site-specific field data.

G.4 References **[February 2002]**

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Simons, Li & Associates, Inc., *Design Manual for Engineering Analysis of Fluvial Systems*, prepared for Arizona Department of Water Resources, Tucson, Arizona, 1985.

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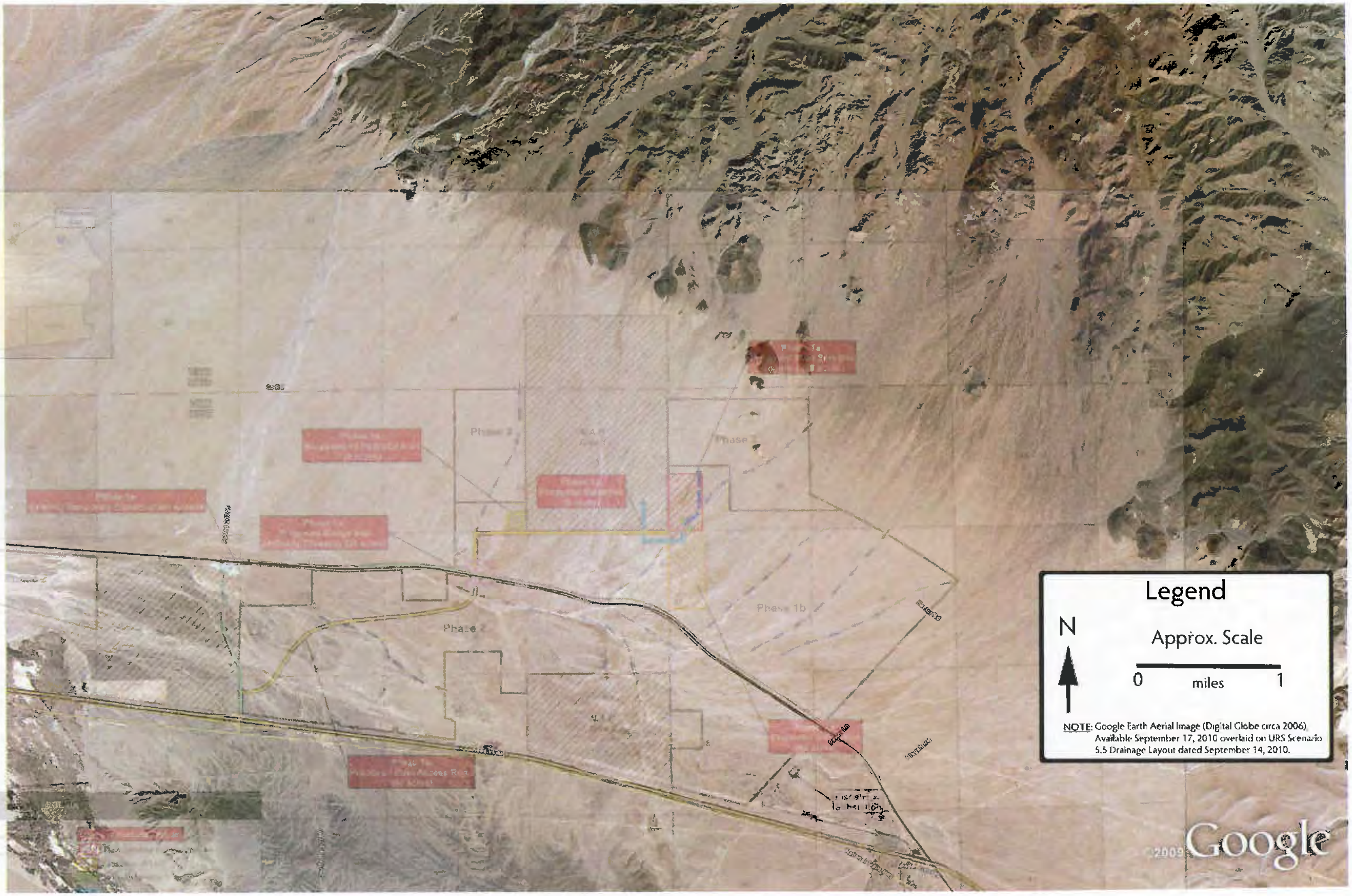
Yang, C. T., and S. Wan, "Comparison of selected bed-material formulas," *ASCE Journal of Hydraulic Engineering*, Vol. 117, p. 973-989, 1991.

Exhibit 5


Phase 2
Phase 1b
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0
miles
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NOTE: Google Earth Aerial Image (Digital Globe circa 2006) Available September 17, 2010 overlaid on URS Scenario 5.5 Drainage Layout dated September 14, 2010.
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Exhibit 6

FEMA

Numerical Models Meeting the Minimum Requirement of NFIP

Nationally Accepted Hydraulic Models as of January 2009

Hydraulic Models: Determination of Water-Surface Elevation for Riverine Analysis

Please reference the following memorandums on the use of HEC-RAS for NFIP purposes. Note that the memorandums are periodically updated, so be sure to read and apply them each time you reference the chart below.

- Policy for Accepting Numerical Models for Use in the NFIP Policy Memorandum
- New Policy for the Use of HEC-RAS in the NFIP

Hydraulic Models: Determination of Water-Surface Elevations for Riverine Analysis

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
One-Dimensional Steady Flow Models			
HEC-RAS 3.1.1 and up	U.S. Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687 www.hec.usace.army.mil/	For water surface elevation difference due to use of different HEC-RAS versions, refer to FEMA Memorandum HEC-RAS Version Updates (August 17, 2004) HEC-RAS Program Update Public Domain: Yes
HEC-2 4.6.2 [1] (May 1991)	US Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	Includes culvert analysis and floodway options. Public Domain: Yes
WSPRO (Jun. 1988 and up)	US Geological Survey, Federal Highway Administration (FHWA)	Federal Highway Administration (FHWA) web page at: www.fhwa.dot.gov/ engineering/hydraulics/ software/softwaredetail.cfm	Floodway option is available in June 1998 version. 1988 version is available on the USGS web page at: water.usgs.gov/software/ surface_water.html Public Domain: Yes

QUICK-2 1.0 and up (Jan. 1995)	FEMA	Federal Emergency Management Agency Federal Insurance and Mitigation Administration 500 C Street, SW Washington, DC 20472 www.fema.gov/plan/prevent/fhm/frm_soft.shtm	Intended for use in areas studied by approximate methods (Zone A) only. May be used to develop water-surface elevations at one cross section or a series of cross sections. May not be used to develop a floodway. Public Domain: Yes
HY8 4.1 and up (Nov. 1992)	US Department of Transportation, Federal Highway Administration (FHWA)	Federal Highway Administration (FHWA) web page at: www.fhwa.dot.gov/engineering/hydraulics/software/softwaredetail.cfm	Computes water-surface elevations for flow through multiple parallel culverts and over the road embankment. Public Domain: Yes
WSPGW 12.96 (Oct. 2000) and up	Los Angeles Flood Control District and Joseph E. Bonadiman & Associates, Inc.	Joseph E. Bonadiman & Associates, Inc. 588 West 6th Street San Bernardino, CA 92410 www.bonadiman.com	Windows version of WSPG. Computes water-surface profiles and pressure gradients for open channels and closed conduits. Can analyze multiple parallel pipes. Road overtopping cannot be computed. Open channels are analyzed using the standard step method but roughness coefficient cannot vary across the channel. Overbank analyses cannot be done. Multiple parallel pipe analysis assumes equal distribution between pipes so pipes must be of similar material, geometry, slope, and inlet configuration. Floodway function is not available. Demo version available from: www.bonadiman.com/software/wspg.htm Public Domain: No
StormCAD v.4 (June 2002) and up	Bentley Systems	Bentley Systems 685 Stockton Drive Exton, PA 19341 www.bentley.com/en-US	Perform backwater calculations. Should not be used for systems with more than two steep pipes (e.g. supercritical conditions). Inflow is computed by using the Rational Method; the program is only applicable to watershed, which has the drainage area to each inlet less than 300 acres. Public Domain: No
PondPack v. 8 (May 2002) and up	Bentley Systems	Bentley Systems 685 Stockton Drive Exton, PA 19341 www.bentley.com/en-US	Cannot model ineffective flow areas. HEC-RAS or an equivalent program must be used to model tail water conditions when ineffective flow areas must be considered. Public Domain: No
Culvert Master v. 2.0 (September 2000), and up	Bentley Systems	Bentley Systems 685 Stockton Drive Exton, PA 19341 www.bentley.com/en-US	Compute headwater elevations for circular concrete and RCB culverts for various flow conditions. Public Domain: No
XP-SWMM 8.52 and up	XP Software	XP Software 5415 SW Westgate Dr. Suite 150 Portland, OR 97221	XP-SWMM cannot represent more than three Manning's n values per channel section. Where more than this number of values per section are required, the user must demonstrate that the three n values used accurately depict the composite n value for the entire section at various depths. The

		www.xpsoftware.com	floodway procedures are for steady flow purposes only. Refer to procedures for unsteady flow floodway calculation posted on the FEMA website at Floodway Analysis for SWMM Models Public Domain: No
Xpstorm 10.0 (May 2006)	XP Software	XP Software 5415 SW Westgate Dr. Suite 150 Portland, OR 97221 www.xpsoftware.com	Xpstorm has the same stormwater modeling capability as the XP-SWMM program.
One-Dimensional Unsteady Flow Models			
HEC-RAS 3.1.1 and up	US Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687 www.hec.usace.army.mil/	Calibration or verification to the actual flood events highly recommended. Floodway concept formulation unavailable. Version 3.1 cannot create detailed output for multiple profiles in the report file. CHECK-RAS cannot extract data. Public Domain: Yes
FEQ 9.98 and FEQUTL 5.46 (2005, both),FEQ 8.92 and FEQUTL 4.68 (1999, both)	Delbert D. Franz, Linsley, Kraeger Associates; and Charles S. Melching, USGS	U.S. Geological Survey 221 North Broadway Avenue Urbana, IL 61801 il.water.usgs.gov/proj/feq/	The FEQ model is a computer program for the solution of full, dynamic equations of motion for one-dimensional unsteady flow in open channels and control structures. The hydraulic characteristics for the floodplain (including the channel, overbanks, and all control structures affecting the movement of flow) are computed by its companion program FEQUTL and used by the FEQ program. Calibration or verification to the actual flood events highly recommended. Floodway concept formulation is unavailable. Public Domain: Yes
ICPR 2.20 (Oct. 2000), 3.02 (Nov. 2002), and 3.10 (April 2008)	Streamline Technologies, Inc.	Streamline Technologies, Inc. 1900 Town Plaza Ct Winter Springs, FL 32708 www.streamnologies.com	Calibration or verification to the actual flood events highly recommended. Floodway concept formulation unavailable; however, version 3 allows user to specify encroachment stations to cut off the cross section. PercPack is currently under FEMA review. Public Domain: No
SWMM 5 Version 5.0.005 (May 2005) and up	U.S. Environmental Protection Agency	Water Supply and Water Resources Division U.S. Environmental Protection Agency www.epa.gov/ednnrmrl/ models/swmm/index.htm	SWMM 5 provides an integrated environment for editing study area input data, running hydrologic simulations, and viewing the results in a variety of formats. Public Domain: Yes

UNET 4.0 (April 2001)	U.S. Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687	Calibration or verification to the actual flood events highly recommended. Comparison of bridge and culvert modeling to other numerical models reveals significant differences in results; these differences may be investigated in the near future. Floodway option is not accepted for NFIP usage. Public Domain: Yes
FLDWAV (Nov. 1998)	National Weather Service	Hydrologic Research Laboratory Office of Hydrology National Weather Service, NOAA 1345 East-West Highway Silver Spring, MD 20910	Includes all the features of DAMBRK and DWOPER plus additional capabilities. It is a computer program for the solution of the fully dynamic equations of motion for one-dimensional flow in open channels and control structures. Floodway concept formulation is unavailable. Calibration to actual flood events required. This model has the capability to model sediment transport. Program is supported by NWS. **National Weather Service FLDWAV Computer Program** Public Domain: Yes
MIKE 11 HD v.2009 SP4	DHI Water and Environment	DHI, Inc. 319 SW Washington St. Suite 614 Portland, OR 97204	Hydrodynamic model for the solution of the fully dynamic equations of motion for one- dimensional flow in open channels and control structures. The floodplain can be modeled separately from the main channel. Calibration to actual flood events highly recommended. Floodway concept formulation is available for steady flow conditions. This model has the capability to model sediment transport. The web page is at: www.dhisoftware.com/mike11/ Public Domain: No
FLO-2D v. 2006.01 and 2007.06	Jimmy S. O'Brien	FLO-2D Software, Inc. P.O. Box 66 Nutrioso, AZ 85932 www.flo-2d.com/	Hydrodynamic model for the solution of the fully dynamic equations of motion for one-dimensional flow in open channels and two-dimensional flow in the floodplain. Bridge or culvert computations must be accomplished external to FLO-2D using methodologies or models accepted for NFIP usage. Calibration to actual flood events required. Floodway option is under review. User of Version 2006.01 is strongly encouraged to update to the latest version for bug correction. Version 2007.06 dated October 25, 2009 has been updated. This model had an incorrect levee weir coefficient value (0.0) that did not permit any levee overtopping. The model with the incorrect weir coefficient may not have been posted until 2010. **Please use the updated Version 2007 model on NFIP studies.**

			Public Domain: No
XP-SWMM 8.52 and up	XP Software	XP Software 5415 SW Westgate Dr. Suite 150 Portland, OR 97221 www.xpsoftware.com	XP-SWMM cannot represent more than three Manning's n values per channel section. Where more than this number of values per section are required, the user must demonstrate that the three n values used accurately depict the composite n value for the entire section at various depths. Calibration to actual flood events required. The floodway procedures are for steady flow purposes only. Use the procedure for unsteady flow floodway calculation posted on FEMA website at Floodway Analysis for SWMM Models Public Domain: No
Xpstorm 10.0 (May 2006)	XP Software	XP Software 5415 SW Westgate Dr. Suite 150 Portland, OR 97221 www.xpsoftware.com	Xpstorm has the same stormwater modeling capability as the XP-SWMM program.
Two-Dimensional Steady/Unsteady Flow Models			
TABS RMA2 v. 4.3 (Oct. 1996) RMA4 v. 4.5 (July 2000)	US Army Corps of Engineers	Coastal Engineering Research Center Department of the Army Waterways Experiment Station Corps of Engineers 3909 Halls Ferry Road Vicksburg, MS 39180-6199	Limitations on split flows. Floodway concept formulation unavailable. More review anticipated for treatment of structures. Public Domain: Yes
FESWMS 2DH 1.1 and up (Jun. 1995)	US Geological Survey	U.S. Geological Survey National Center 12201 Sunrise Valley Drive Reston, VA 22092 water.usgs.gov/software/surface_water.html	Region 10 has conducted study in Oregon. Floodway concept formulation unavailable. This model has the capability to model sediment transport. Public Domain: Yes
FLO-2D v. 2006.01 and 2007.06	Jimmy S. O'Brien	FLO-2D Software, Inc. Tetra Tech, ISG P.O. Box 66 Nutrioso, AZ 85932 www.flo-2d.com/	Hydrodynamic model that has the capabilities of modeling unconfined flows, complex channels, sediment transport, and mud and debris flows. It can be used for alluvial fan modeling. Floodway option is under review. User of Version 2006.01 is strongly encouraged to update to the latest version for bug correction. Public Domain: No
MIKE Flood HD v.2009 SP4	DHI Water and Environment	DHI, Inc. 319 SW Washington St. Suite 614 Portland, OR 97204	A dynamic coupling of MIKE 11 (one-dimensional) and MIKE 21 (two-dimensional) models. Solves the fully dynamic equations of motion for one- and two-dimensional flow in open channels, riverine flood plains, alluvial fans and in costal zones. This allows for embedding of sub-grid features as 1-D links within a 2-D modeling domain. Examples of sub-grid features could

			include small channels, culverts, weirs, gates, bridges and other control structures. Calibration for actual flood events is highly recommended. The web page is at www.dhisoftware.com/mikeflood/ Public Domain: No

[1] The enhancement of the program in editing and graphical presentation can be obtained from several private companies.

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Hydrologic Models

Hydrologic Models: Determination of Flood Hydrographs

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
Single Event			
HEC-1 4.0.1 and up [1] (May 1991)	U.S. Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687	Flood hydrographs at different locations along streams. Calibration runs preferred to determine model parameters. Public Domain: Yes
HEC-HMS 1.1 and up (Mar 1998)	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	The Hydrologic Modeling System provides a variety of options for simulating precipitation-runoff processes. Now includes snowmelt and interior pond capabilities, plus enhanced reservoir options. Calibration runs should be used wherever possible to determine model parameters. Public Domain: Yes
TR-20 Win 1.00 (Jan 2005)	U.S. Department of Agriculture, Natural Resources Conservation Service	U.S. Department of Agriculture, Natural Resources Conservation Service	The TR-20 computer model has been revised and completely rewritten as a Windows based program. It is storm event surface water hydrologic model applied at a watershed scale that can generate, route, and combine hydrographs at points within a watershed. Calibration runs preferred to determine model parameters. Public Domain: Yes
WinTR-55 1.0.08 (Jan 2005)	U.S. Department of Agriculture, Natural Resources Conservation Service	U.S. Department of Agriculture, Natural Resources Conservation Service	The new WinTR-55 uses the WinTR-20 program as the driving engine for analysis of the hydrology of the small watershed system being studied. Public Domain: Yes
SWMM 5 Version 5.0.005	U.S. Environmental Protection Agency	Water Supply and Water Resources Division	SWMM 5 provides an integrated environment for editing study area input data, running hydrologic simulations, and viewing the results in a variety of

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
(May 2005) and up		U.S. Environmental Protection Agency	formats. These include color-coded drainage area and conveyance system maps, time series graphs and tables, profile plots, and statistical frequency analyses. Calibration or verification to the actual flood events highly recommended. Public Domain: Yes
MIKE 11 (2009 SP4)	DHI Water and Environment	DHI, Inc. 319 SW Washington St. Suite 614 Portland, OR 97204	Simulates flood hydrographs at different locations along streams using unit hydrograph techniques. Three methods are available for calculating infiltration losses and three methods for converting rainfall excess to runoff, including SCS Unit hydrograph method. Calibration or verification to the actual flood events highly recommended. Public Domain: No
PondPack v.8 (May 2002) and up	Bentley Systems	Bentley Systems 685 Stockton Drive Exton, PA 19341	The program is for analyzing watershed networks and aiding in sizing detention or retention ponds. Only the NRCS Unit Hydrograph method and NRCS Tc calculation formulas are acceptable. Other hydrograph generation methods or Tc formulas approved by State agencies in charge of flood control or floodplain management are acceptable for use within the subject State. Calibration or verification to the actual flood events highly recommended. Public Domain: No
XP-SWMM 8.52 and up	XP-Software	XP Software 5415 SW Westgate Dr. Suite 150 Portland, OR 97221 www.xpsoftware.com	Model must be calibrated to observed flows, or discharge per unit area must be shown to be reasonable in comparison to nearby gage data, regression equations, or other accepted standards for 1% annual chance events. Calibration or verification to the actual flood events highly recommended. Public Domain: No
Xpstorm 10.0 (May 2006)	XP Software	XP Software 5415 SW Westgate Dr. Suite 150 Portland, OR 97221 www.xpsoftware.com	Xpstorm has the same stormwater modeling capability as the XP-SWMM program. Calibration or verification to the actual flood events highly recommended.
Continuous Simulation			
HSPF 10.10 and up (Dec 1993)	U.S. Environmental Protection Agency, U.S. Geological Survey	Center for Exposure Assessment Modeling U.S. Environmental Protection Agency Office of Research and Development Environmental Research Laboratory	Calibration to actual flood events required. Water Resources Application Software Public Domain: Yes

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
		960 College Station Road Athens, GA 30605-2720	
HEC-HMS 3.0 and up (Dec 2005)	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	The Hydrologic Modeling System (HMS) includes two different soil moisture models suitable for continuous modeling, one with five layers and one with a single layer. Two approaches to evapotranspiration are provided and snowmelt is available. Calibration to actual flood events is required. Public Domain: Yes
MIKE 11 RR (2009 SP4)	DHI Water and Environment	DHI, Inc. 319 SW Washington St. Suite 614 Portland, OR 97204	The Rainfall-Runoff Module is a lumped-parameter hydrologic model capable of continuously accounting for water storage in surface and sub-surface zones. Flood hydrographs are estimated at different locations along streams. Calibration to actual flood events is required. MIKE 11 River Modelling Public Domain: No
PRMS Version 2.1 (Jan 1996)	U.S. Geological Survey	U.S. Geological Survey 12201 Sunshine Valley Drive Reston, VA 22092 U.S. Geological Survey P.O. Box 25046, Mail Stop 412 Denver Federal Center Lakewood, CO 80225-0046	PRMS is a modular-designed, deterministic, distributed-parameter modeling system that can be used to estimate flood peaks and volumes for floodplain mapping studies. Calibration to actual flood events required. The program can be implemented within the Modular Modeling System) that facilitates the user interface with PRMS, input and output of data, graphical display of the data, and an interface with GIS. Public Domain: Yes

[1] The enhancement of the program in editing and graphical presentation can be obtained from several private companies.

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Statistical Models

Statistical Models

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
HEC FFA 3.1 (February 1995)	U.S. Army Corps of Engineers	Water Resources Support Center [1] Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	Performs flood frequency analyses following Bulletin 17B, *Guidelines for Determining Flood Flow Frequency*, prepared by the Interagency Advisory Committee on Water Data (1982). Supersedes HECWRC. Public Domain: Yes
PEAKFQ 2.4 (April 1998) and up	U.S. Geological Survey	U.S. Geological Survey Hydrologic Analysis Software Support Team 437 National Center Reston, VA 20192	Performs flood frequency analyses following Bulletin 17B, *Guidelines for Determining Flood Flow Frequency*, prepared by the Interagency Advisory Committee on Water Data (1982). Public Domain: Yes
FAN	FEMA	The Mod Team 3601 Eisenhower Avenue Alexandria, VA 22304	FAN, Alluvial Fan Flooding software, is used to define special flood hazard information in areas subject to alluvial fan flooding. The model does not define the extent of the special flood hazard area (SFHA), rather, develops output information that can, in conjunction with soil, topographic, and geomorphic information, be used to divide the SFHA into zones of similar depth and velocity. The minimum input required is the flood-frequency relation at the apex. Options allow for consideration of multiple flow paths with or without avulsions during flood events. NFIP software list Public Domain: Yes

[1] Program is typically distributed by vendors and may not be available through HEC. A list of vendors may be obtained through HEC.

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Hydraulic Models: Determination of Water-surface Elevations for Riverine Analysis

Hydraulic Models: Determination of Water-surface Elevations for Riverine Analysis

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
One-Dimensional Unsteady Flow Models			
HCSWMM 4.31B (Aug. 2000)	Stormwater Management Section Public Works Department Hillsborough County, Florida	Stormwater Management Section Public Works Department Hillsborough County, Florida 601 E. Kennedy Boulevard 21st Floor P.O. Box 1110 Tampa, FL 33601	Modified version of EPA SWMM 4.31. The major modifications are: integrated the SCS-CN method into the model to calculate the rainfall-runoff process; allow up to 21 different Manning's coefficients for each cross-section; added 4 more fields to C1 line to calculate the exit, entrance, and other minor losses, and to stretch the pipe based on stability condition automatically create an ASCII file, HYDROG.DAT, containing hydrograph for each subbasin generated after each run. **Only accepted for usage and applicable within** Hillsborough County, Florida. Public Domain: Yes
ICPR v.3.10 with PercPack Option	Streamline Technologies	Streamline Technologies, Inc. 1900 Town Plaza Ct. Winter Springs, Florida 32708-6208 www.streamnologies.com	Add-on to ICPR, modeling the interactions between surface water systems and the groundwater table. Must follow FEMA "Guidelines for Estimation of Percolation Losses for NFIP Studies" in using the model to simulate percolation process. Only accepted for usage in FEMA Region IV. Public Domain: No
NETWORK (Jun. 2002)	Southwest Florida Water Management District	Engineering Section Resource Management Department 2329 Broad Street Brooksville, Florida 34604-6899	Interconnected ponds and channels routing model. **Only accepted for usage within Southwest Florida Water Management District.** Public Domain: Yes
CHAN for Windows v.2.03 (1997)	Aquarian Software, Inc.	Aquarian Software 1415 Briercliff Drive Orlando, Florida 34604-6899	Calibration or verification to the actual flood events highly recommended. Floodway concept formulation is unavailable. Encroachment stations can be specified in editor to cut off section.

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
			Only accepted for usage within Southwest Florida Water Management District. Public Domain: No
Two-Dimensional Unsteady Flow Models			
S2DMM (Feb. 2008)	Tomasello Consulting Engineers, Inc.	Tomasello Consulting Engineers, Inc. 5906 Center Street Jupiter, FL 33458	Applicable to a network of rectangular grids. Capable of routings on natural overland sheetflow areas and water management systems with cascading lakes and channels. Computing runoff from either daily or hourly rainfall with design distributions, using SCS formula with soil storage and soil moisture updated on daily basis. Stage/storage, sheetflow cross sections, and soil types are represented in each computational grid entered via GIS. HEC-2 type cross sections can be entered on specific channel grids and minor channels can be embedded on general grids. Evapotranspiration computations are based on seasonal factors and soil moisture of unsaturated and saturated zones. Interactions with the subsurface conditions are handled by MODFLOW routines. Capable of simulating continuous hydrologic conditions. Cannot compute regulatory floodway. **Only accepted for usage in the South Florida Water Management District.** Public Domain: No
Two-Dimensional Steady/Unsteady Flow Models			
DHM 21 and 34 (Aug. 1987)	Theodore V. Hromadka II and Chung-Cheng Yen	Hromadka & Associate Costa Mesa, California	Diffusion flow model that can route unconfined surface and open channel flows. Can be used to model alluvial flooding. Rainfall-runoff output can be used for hydrologic studies. Kinematic routing optional. Floodway concept formulation unavailable. Calibration to actual flood events is recommended. **Only accepted for usage within the San Bernardino County Flood Control District, California.** Public Domain: No

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- Numerical Models No Longer Accepted by FEMA for NFIP Usage

FEMA

Numerical Models Meeting the Minimum Requirement of NFIP

Current Locally Accepted Hydrologic Models

- Hydrologic Models: Determination of Flood Hydrographs
- View More Locally Accepted Models
- Nationally Accepted Models
- Numerical Models No Longer Accepted

Hydrologic Models: Determination of Flood Hydrographs

Hydrologic Models: Determination of Flood Hydrographs

PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS
Single Event			
AHYMO 97 (Aug. 1997)	Albuquerque Metropolitan Arroyo Flood Control Authority, Anderson-Hydro	Anderson-Hydro 13537 Terragon Drive, NE Albuquerque, NM 87112	Flood hydrographs at different locations along streams. **Only accepted for usage and the default parameters in the model applicable within New Mexico.** Information on the AHYMO model Public Domain: Yes
Colorado Urban Hydrograph Procedure (CUHPF/PC) (May 1996 and May 2002)	Denver Urban Drainage and Flood Control District	Denver Urban Drainage and Flood Control District 2480 West 26th Avenue, Suite 156-B Denver, CO 80211	Flood hydrographs at different locations along streams. Hydrographs are routed using UDSWM2-PC (a modified version of the Runoff Block of EPA's SWMM). **Only accepted for usage and the default parameters in the model applicable within the Denver, Colorado, metro area.** Public Domain: Yes

View More Locally Accepted Models

- Coastal Models Meeting the Minimum Requirement of NFIP
- Hydraulic Models Meeting the Minimum Requirement of NFIP

Nationally Accepted Models

- Coastal Models Meeting the Minimum Requirement of NFIP
- Hydrologic Models Meeting the Minimum Requirement of NFIP
- Statistical Models Meeting the Minimum Requirement of NFIP

- Hydraulic Models Meeting the Minimum Requirement of NFIP

Numerical Models No Longer Accepted

- Numerical Models No Longer Meeting the Minimum Requirement of NFIP

FEMA

Numerical Models No Longer Accepted by FEMA for NFIP Usage

Currently Unacceptable Models

- Current Unacceptable Models
- Nationally Accepted Models
- Locally Accepted Models

Current Unacceptable Models

Currently Unacceptable Numerical Models

TYPE	PROGRAM	DEVELOPED BY	COMMENTS
Coastal Models; Coastal Storm Surges	ODISTIM (1975)	Coastal Consultants, Inc.	Have not been used for NFIP studies for more than 5 years.
	Northeaster Model (1978)	Stone & Webster Engineering Group	
	FLOW2D (1975) [1]	Resource Analysis, Inc.	
Coastal Models; Coastal Wave Effects	GLWRM (1992)	U.S. Army Corps of Engineers	Have not been used for NFIP studies for more than 5 years.
Hydrologic Models; Single Event	DBRM 3.0 (1993)	Bernard L. Golding, P.E. Consulting Water Resources Engineer Orlando, FL	Have not been used for NFIP studies for more than 5 years.
	HYMO	U.S. Department of Agriculture, Natural Resources Conservation Service	NRCS is no longer supporting the program.
	DR3M (Oct. 1993)	U.S. Geological Survey	Have not been used for NFIP studies for more than 5 years.
	TR-20 (February 1992)	U.S. Department of Agriculture, Natural Resources Conservation Service	NRCS is no longer supporting the DOS version of the program.
	TR-55 (June 1986)	U.S. Department of Agriculture, Natural Resources Conservation Service	NRCS is no longer supporting the DOS version of the program.
Interior Drainage Analysis	HEC-IFH 1.03 and up	U.S. Army Corps of Engineers	The U.S. Army Corps of Engineers is no longer supporting the program.

Hydraulic Model; One-dimensional Steady Flow	WSP2 (October 1993)	U.S. Department of Agriculture, Natural Resources Conservation Service	NRCS is no longer supporting the program.
	FLDWY (May 1989)	U.S. Department of Agriculture, Natural Resources Conservation Service	NRCS is no longer supporting the program; for past studies done using FLDWY, the user manual is still available from NRCS to help interpret the data.
Hydraulic Model; One-dimensional Unsteady Flow	UNET 4.0 (Apr. 2001)	US Army Corps of Engineers	Replaced by HEC-RAS.
	DAMBRK	National Weather Service	NWS is no longer supporting the program.
	NETWORK (DWOPER)	National Weather Service	NWS is no longer supporting the program.
Floodway Model	SFD	U.S. Army Corps of Engineers / FEMA	The U.S. Army Corps of Engineers / FEMA are no longer supporting the program.
	PSUPRO	Pennsylvania State University / U.S. Army Corps of Engineers / FEMA	Pennsylvania State University / U.S. Army Corps of Engineers / FEMA are no longer supporting the program.
Locally Accepted Hydraulic Model	SHEET2D 9	Tomasello Consulting Engineers, Inc.	Replaced by S2DMM.

Nationally Accepted Models

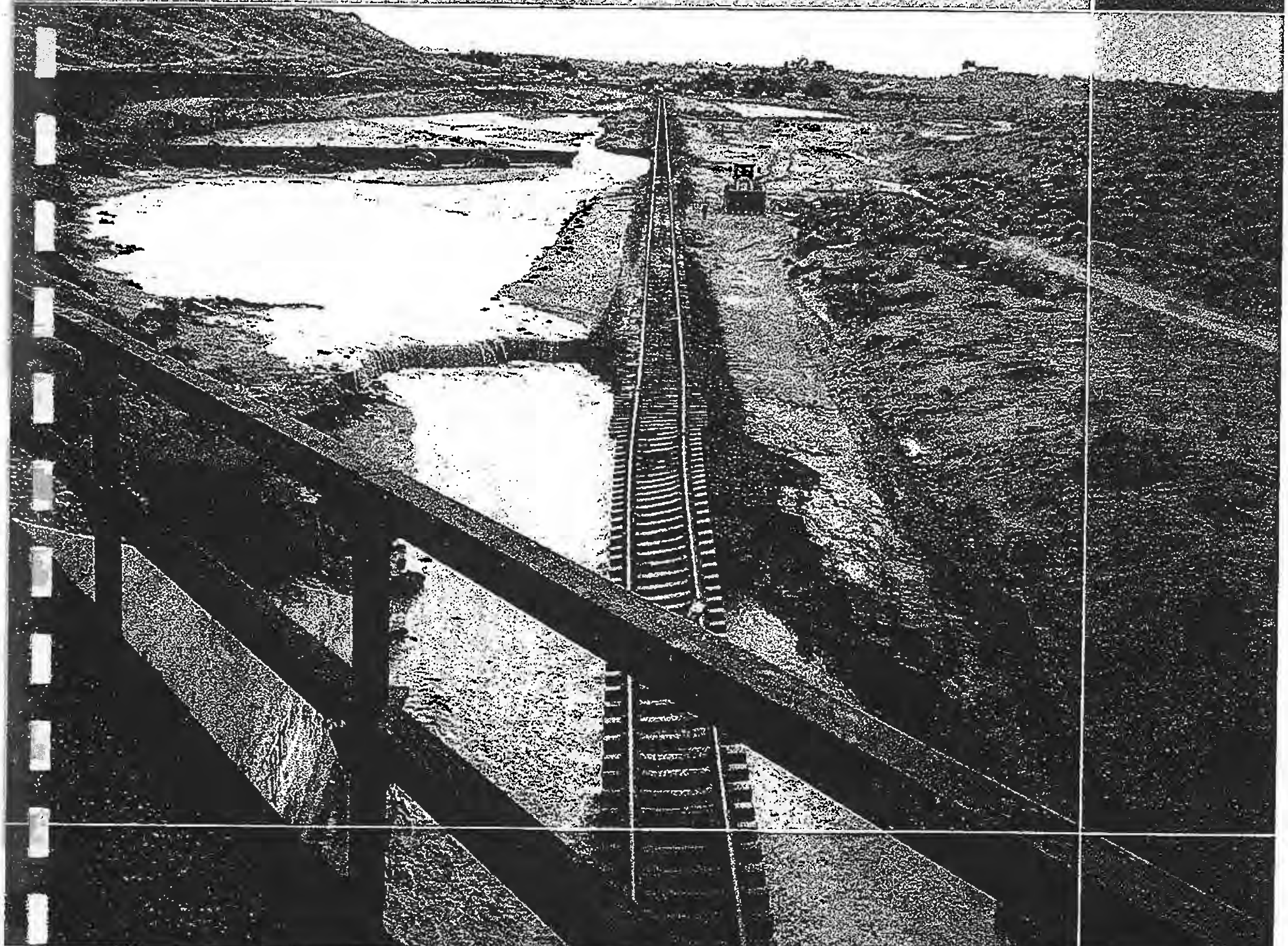
- Coastal models accepted by FEMA for NFIP usage
- Hydrologic models accepted by FEMA for NFIP usage
- Statistical models accepted by FEMA for NFIP usage
- Hydraulic models accepted by FEMA for NFIP usage

Locally Accepted Models

- Coastal Models Meeting the Minimum Requirement of NFIP
- Hydraulic Models Accepted by FEMA for NFIP usage
- Hydrologic Models Accepted by FEMA for NFIP usage

Return to the Numerical Models Page.

Exhibit 7



prepared for:

BNSF Burlington Northern Santa Fe Railway

BNSF 003241

by:

HANSON WILSON INCORPORATED

August 20, 2004

BNSF Flooding Analysis

At

MP 39.0 to 41.0
Cajon Subdivision

Burlington Northern Santa Fe

BNSF

Prepared by:

HANSON WILSON INCORPORATED

Hanson-Wilson Inc.
275 W. Hospitality Lane, Suite 300
San Bernardino, CA 92408
909/806-8000

BNSF 003242

X4-510-157

August 20, 2004

BNSF FLOODING ANALYSIS
MILEPOST 39.0 to 41.0 – CAJON SUBDIVISION

This report provides documentation and background information regarding the recent flooding at The Burlington Northern and Santa Fe Railway Company's (BNSF's) track between Mileposts (MP) 39.0 and 41.0 on the Cajon Subdivision. The storm event occurred at approximately 3:30 p.m. on Saturday, August 14, 2004. According to the City of Victorville, approximately 2 inches of rain fell in some areas of Victorville in a one-hour period. The result of this rainfall was extreme runoff and damage to BNSF's track at several locations between MP 39.0 and MP 41.0 and the natural crossover structure at MP 39.14.

An aerial photo of the track and structures in the immediate vicinity of the study area is shown on Figure 1. As further background, stormwater runoff is collected along the west side of the tracks in an open ditch from MP 41.0 north to MP 39.4. This flow is then conveyed through Track Number 1 at MP 39.4 with a 42-foot bridge and three 48-inch corrugated metal pipes (cmp's). The runoff continues to the north and passes through the embankment at MP 39.23, which is an 8-ft x 8-ft cast in place arch culvert.

Bridge 39.14 and the Number 1 track though the bridge sustained substantial damage as a result of overflow and limited capacity from the structures upstream and to the south of this bridge. Bridge 39.14 is the grade separation bridge for the natural crossover and is not designed or intended to convey stormwater. In fact, the footing of the bridge is on relatively shallow spread footings that made it more susceptible to scour damage. During Saturday's storm event, runoff was limited by the conveyance of the 8-ft x 8-ft arch pipe at MP 39.23 on Track Number 2 and was forced to flow to the north and through Bridge 39.14. The results were extensive scour to the foundation of the bridge and to the track structure in the immediate area. A high water mark is shown in Photo 5.

The drainage basin that contributes runoff to this outflow consists of approximately 17 square miles of predominantly residential and commercially developed property with some areas that have not yet been developed. The majority of that area, approximately 75 percent, lies within the City of Hesperia to the south. The northern 25 percent of the basin lies within the City of Victorville and is currently under development for commercial use.

In addition to the structures at MP 39.4 and MP 39.23, there are three detention ponds at the lower end of the drainage basin that are intended to attenuate the peak flow. These detention ponds are shown on Figure 1. It is unclear what the condition of the detention ponds were before the storm event. However, a considerable volume of sand was removed from the lower ponds after the flood event. The upper detention pond, located at MP 40 actually diverted flow around the dam and into the track, washing out a portion of the ballast (see photos 8 and 9).

BNSF 003243

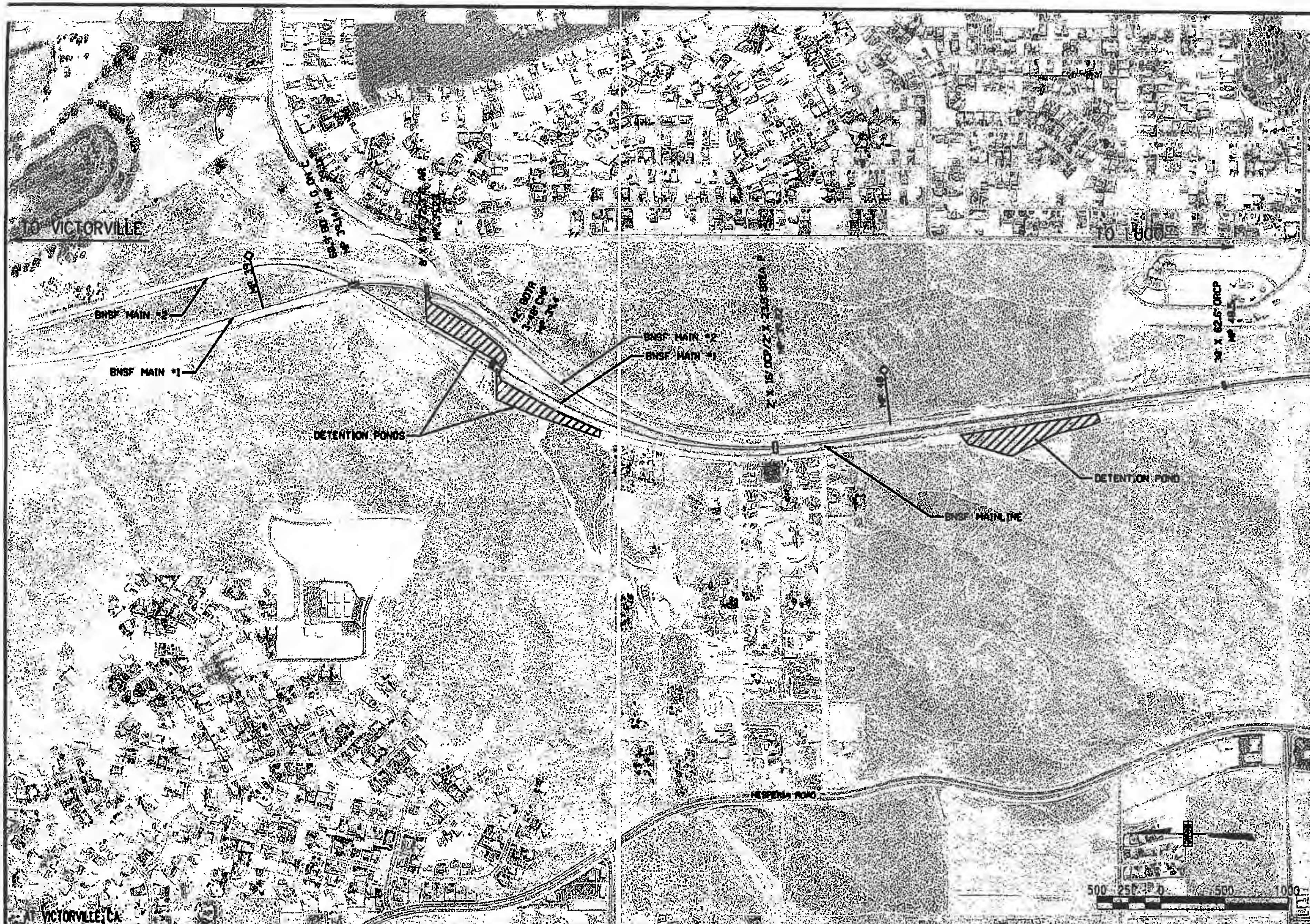


FIGURE 1

HANSON WILSON INCORPORATED
275 W. HOSPITALITY LANE STE. 300
SAN BERNARDINO, CALIFORNIA 92408
PHONE: 909-806-8000
FAX: 909-806-8099

FILE: victorville2.dgn	
DESIGNED	
CHECKED	
DRAWN	GAM
CHECKED	CJS

NATURAL CROSSOVERS
MP 39.1

SHEET 1

8-19-04

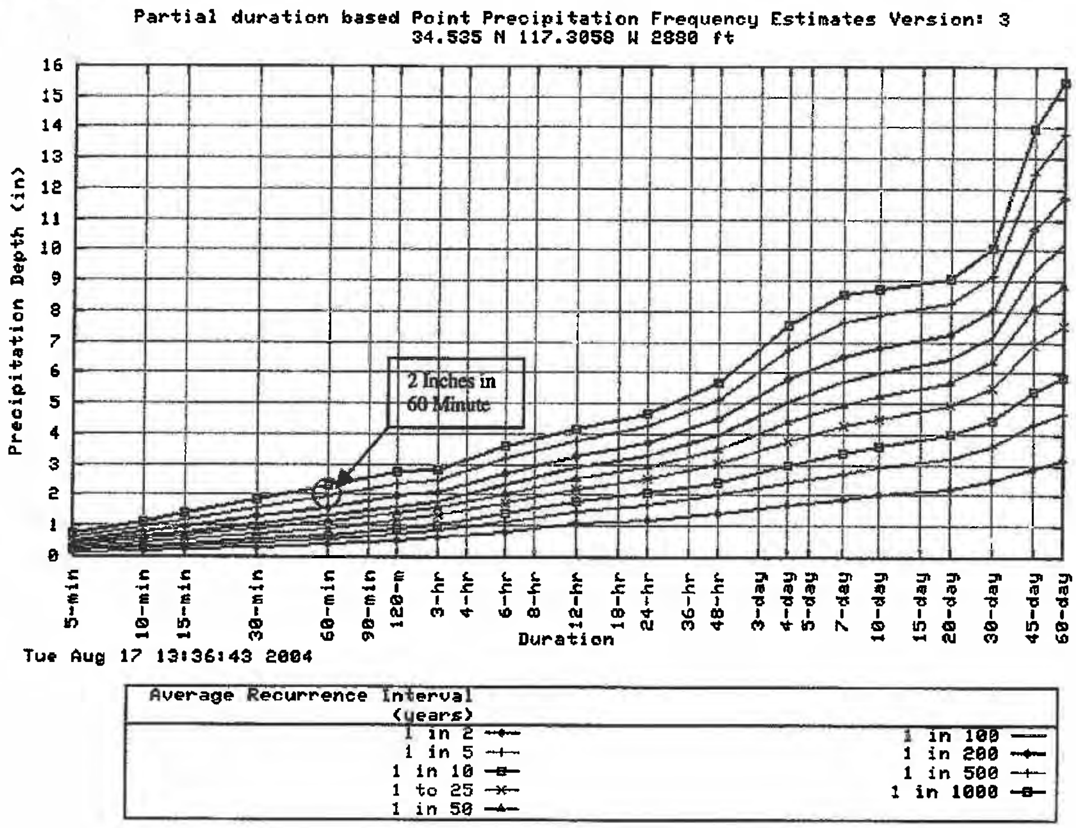
BNSF 003244

In addition to the detention ponds upstream, the City of Victorville has constructed a concrete lined channel to collect and control the runoff in a portion of the upstream channel. However, this channel construction is not complete and portions of the channel are lined with riprap along the track side of the channel. A large scour hole has developed at the downstream end of the concrete channel (see photos 10,11 &12). This scour will cause damage in the future to the track structure unless counter measures are implemented by the City of Victorville. San Bernardino County owns a portion of the unimproved upstream channel, between approximately MP 39.58 and 39.97.

Precipitation Analysis

Significant precipitation occurs infrequently in the Victorville/Hesperia area. The average annual precipitation is 5 inches, with 70 percent falling between October and March. These months usually produce general winter storms of low intensity and long duration. The months of April through September usually yield thunderstorms of high intensity and short duration. These thunderstorms occur, on the average, three times a year.

Rainfall data was collected to compare Saturday's event with isohyetal maps and point precipitation frequency estimated for the immediate area (see Figure 2) to identify the frequency of the storm. Figure 2 shows that 2 inches of rainfall falling in a 60-minute period has a recurrence interval of approximately once in every 500 years.



VICTORVILLE, CALIFORNIA (04-9325) 34.535°N 117.3058°W 2880 feet
from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 3
G.M. Bonnin, D. Todd, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2003

Figure 2

The Hanson-Wilson team obtained precipitation from the California Department of Water Resources Internet real time data service. Data from the Mormon Rock (MRN), Granite Mountain (GAM) and the Victorville Pump Plant (VCT) were accessed. The rainfall information obtained from this source showed little if any activity during the time frames of the flooding event. Our team also accessed other Internet weather monitoring devices but the information was similar in nature. Our conclusions from these data sources indicate the storm cell over the area was small and focused on the upper area of the drainage basin, but had very high intensity.

Hanson-Wilson staff members collected and researched local accounts that appeared in the newspaper and local police and fire stations were called for rain gage data. The San Bernardino Sun reported the storm dumped between 2 to 3 inches of hail and rain in a one-hour time frame. A rain gage located on Bear Valley Road reported 0.83 inches of rainfall. The City of Victorville reported that approximately 2 inches of rain fell in a one-hour period

The last source of rainfall information used was the BNSF Weather Data Service. A flash flood advisory, Warning 2011, was issued between Saturday at 1:30 p.m. PDT to 3:30 p.m. PDT on August 14, 2004. From this advisory notice, we were able to obtain storm Doppler information during the timeframe of the event. The Doppler information from the storm was also converted into Surface Rainfall Accumulation on an hourly basis and Storm Total Rainfall Accumulation maps for the event. Hanson-Wilson was then able to superimpose the drainage shed of the natural crossover area onto these maps. Preliminary investigation of the data from this source shows areas of the shed received between 0.2 inches to 2 inches of rain. These maps are shown in the Appendix.

Considering the rainfall data that our team gathered and personal accounts of the storm, it is our opinion that approximately 2 inches of rain fell within a 60-minute period in the lower portion of this basin. This correlates to a rainfall event with a frequency of between 100 and 500 years. It should be noted that this depth of rainfall was not evenly distributed over the entire basin. In fact, some areas of the basin received very little precipitation. Accordingly, there is no direct correlation between the frequency of the rainfall event and the runoff event; e.g., a 500-year storm over a small portion of the drainage basin will not produce a 500-year runoff event at the outlet of the basin.

Hydraulic Analysis

A hydraulic analysis was completed to estimate the peak flow during Saturday's flooding and estimate the frequency of the runoff. High-water lines were identified at Bridge 39.14, (see photo 5) and also at a location approximately 1,800 feet upstream of Bridge 39.4. Considering the amount of scour that occurred at Bridge 39.14 and the uncertainty of the channel section during the runoff event, it was decided to correlate the peak flow with the cross-sections upstream of Bridge 39.14.

The two channel sections were modeled with the Corps of Engineer's HEC-RAS hydraulic program. The flow was iterated in the model until the hydraulic grade line at the upstream section matched the surveyed high water mark at that location. There was good correlation to the high water line at the second channel cross-section with this flow. The peak flow obtained from the model is approximately 1,900 cfs.

The *Williams & Schmid Master Plan of Drainage* for the cities of Victorville and Hesperia estimates the fully developed 100-year flow to be 2,070 cfs at this same location, which is 170 cfs more than we estimated in our drainage model. This estimate assumes that the drainage basin is fully developed. Considering that a portion of the basin is not developed, it is likely that this runoff event was greater than the 100-year runoff event.

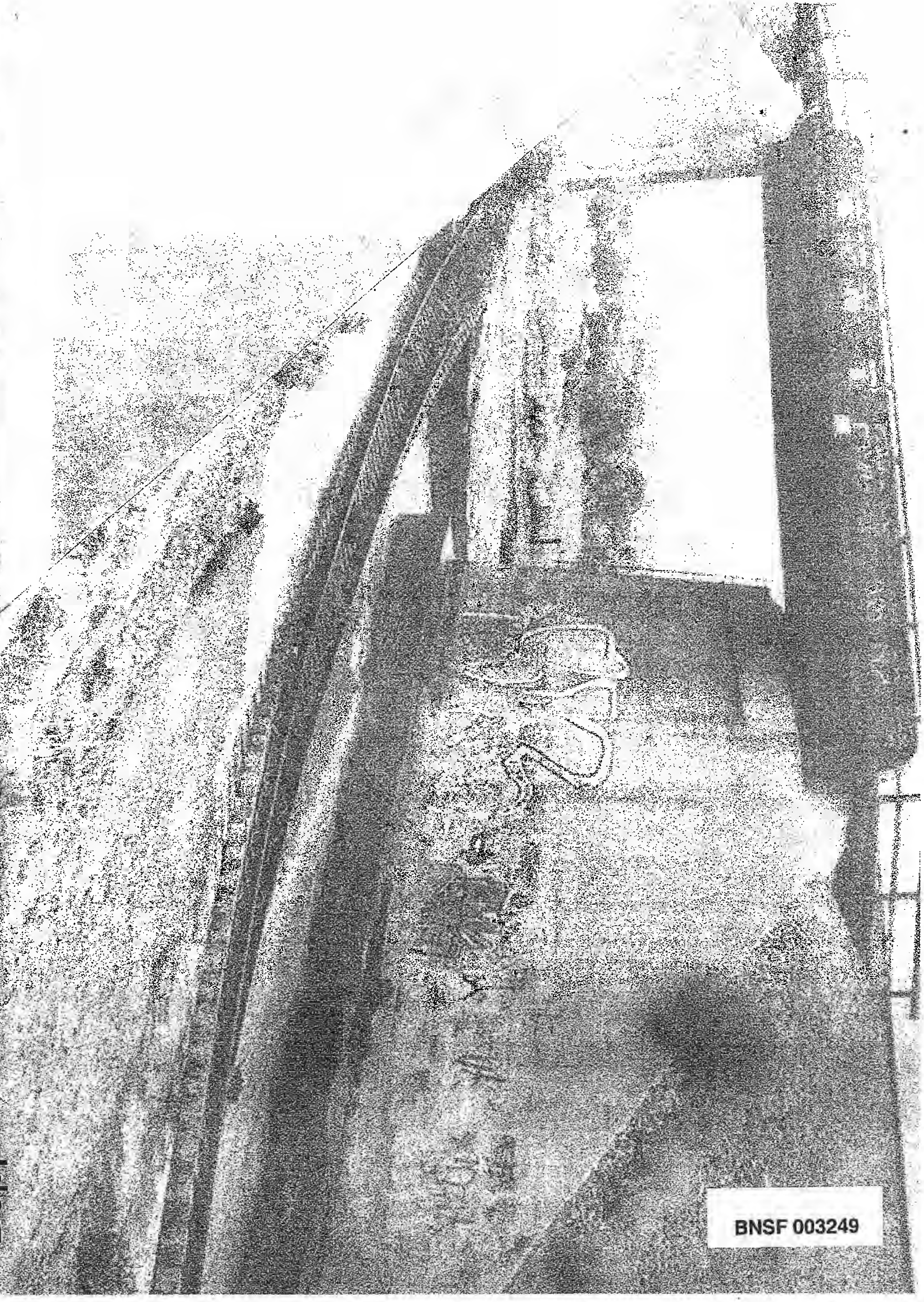
Summary

The runoff from this storm was on the number 2 track near or above that of a 100-year flood event. However, there are two factors that caused the drainage system to fail and cause flow to be diverted south to Bridge 39.14 and wash out the track and scour the footings of the bridge.

The first contributing factor was the size of the conveyance structure located at MP 39.23. The 8-ft x 8-ft arch pipe did not have the capacity to carry the peak flow and consequently water built up to the west of the inlet and breached the dike, diverting the majority of the peak flow to Bridge 39.14.

The second contributing factor to the damage was the amount of storage provided in the three detention ponds. It is uncertain what the condition of the detention ponds was prior to the storm. However, if the ponds were not properly maintained by removing the collected sediment from previous storms, the peak flow would have reached the 8-ft x 8-ft arch pipe at MP 39.23 without being attenuated and resulted in overflow to the grade separation at MP 39.14.

Doppler Rainfall Information



BNSF 003249

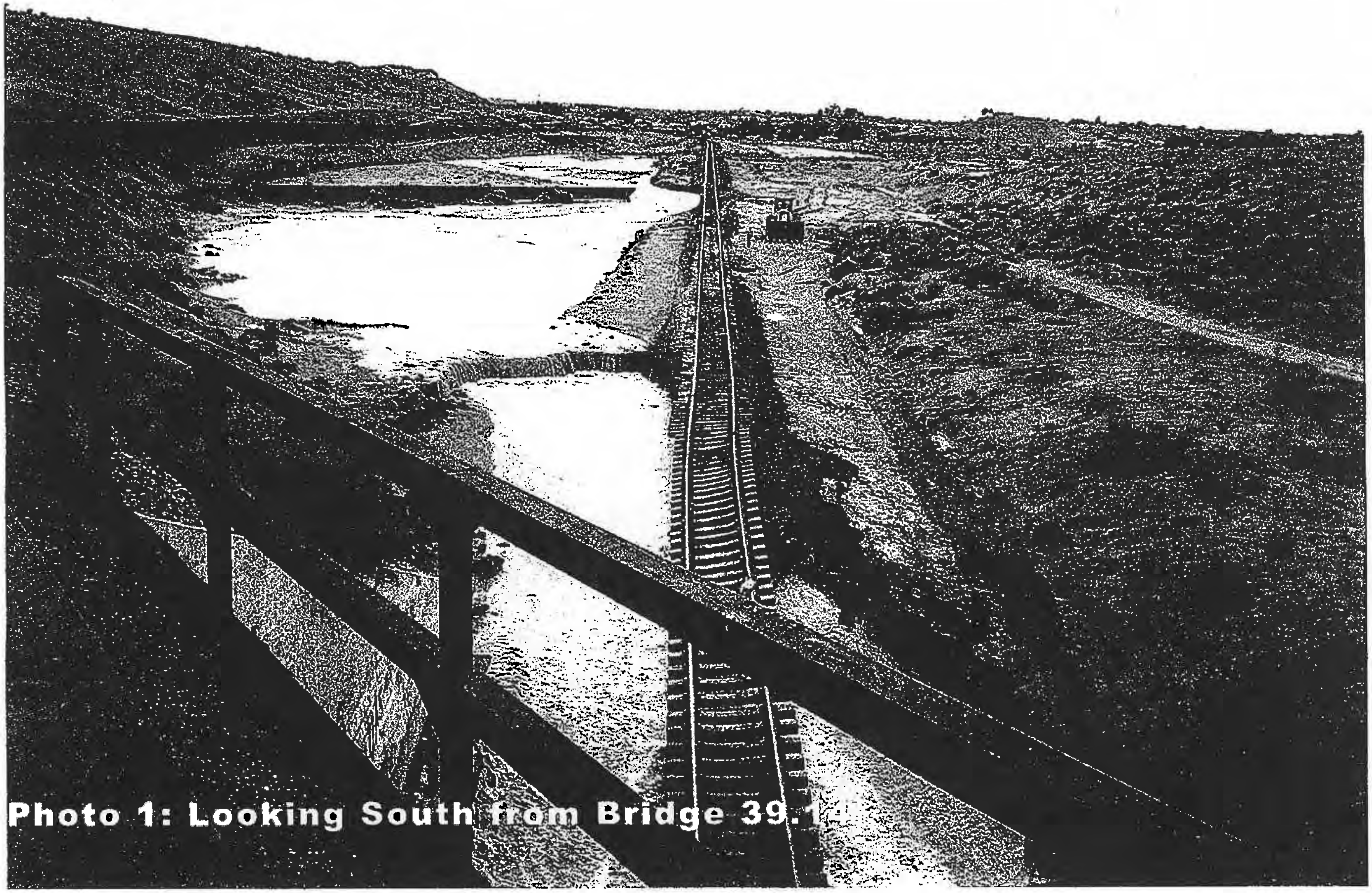


Photo 1: Looking South from Bridge 39.1

BNSF 003252

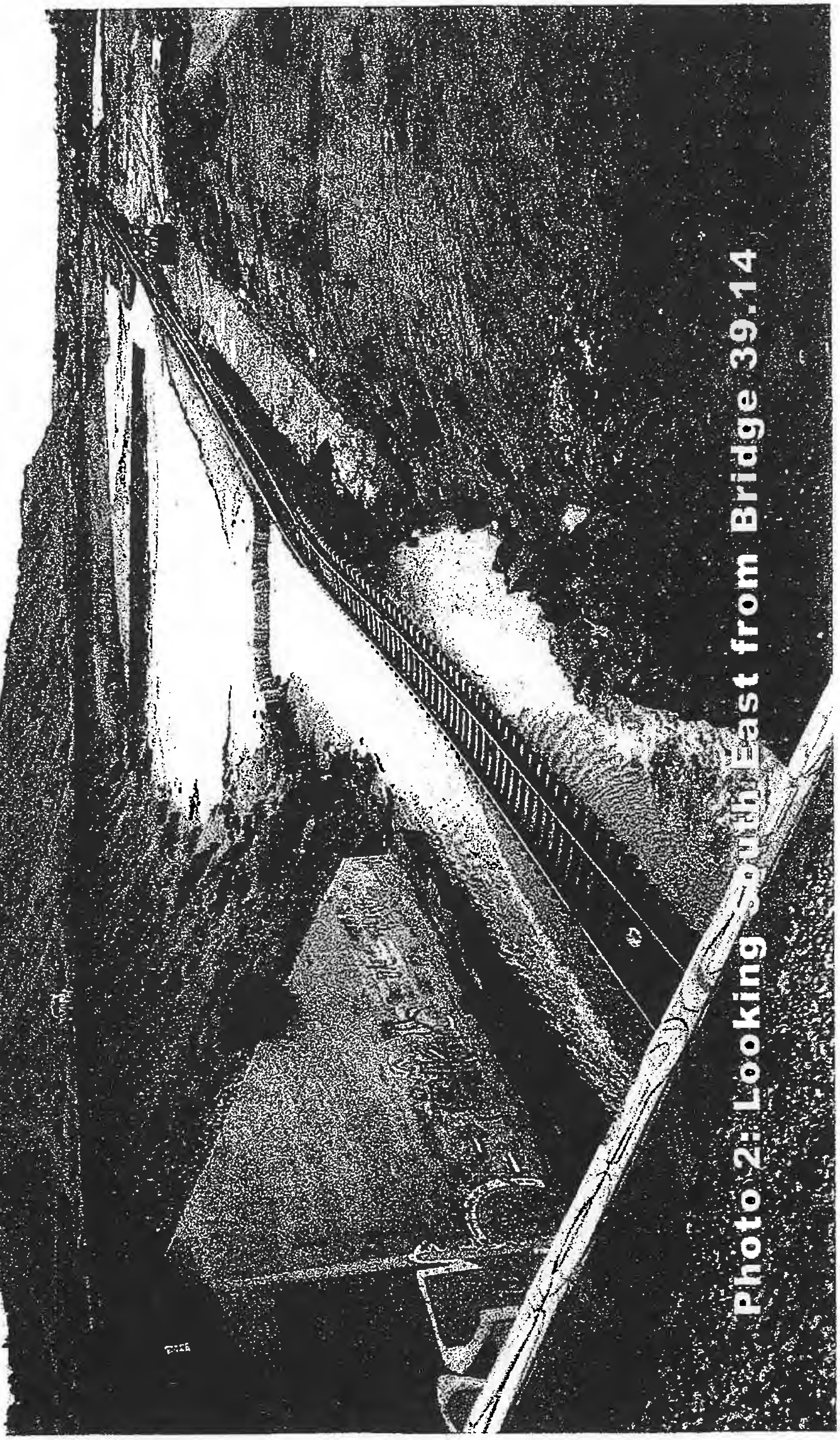


Photo 2: Looking South East from Bridge 39.14

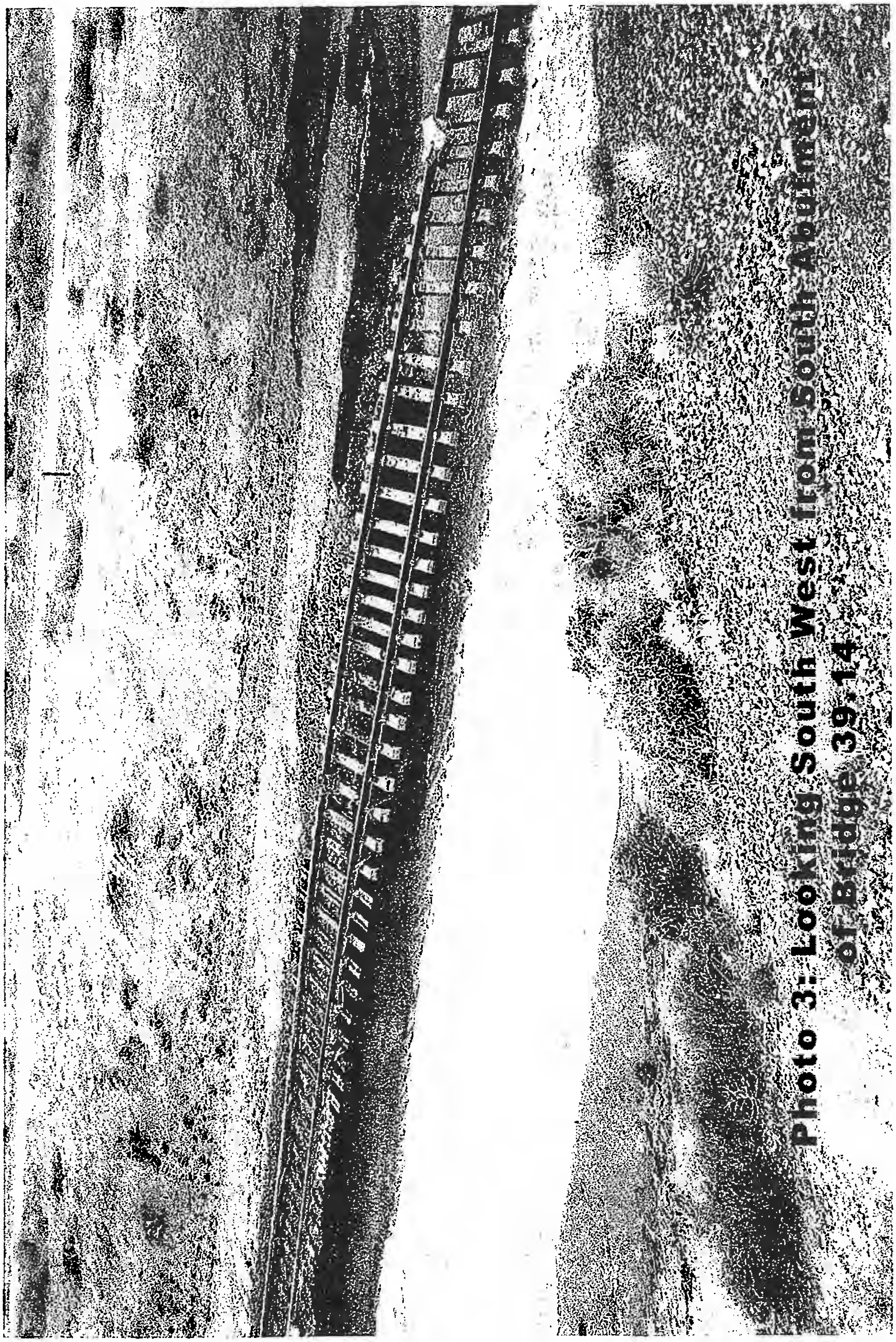


Photo 3: Looking South West from South Abutment of Bridge 39.14

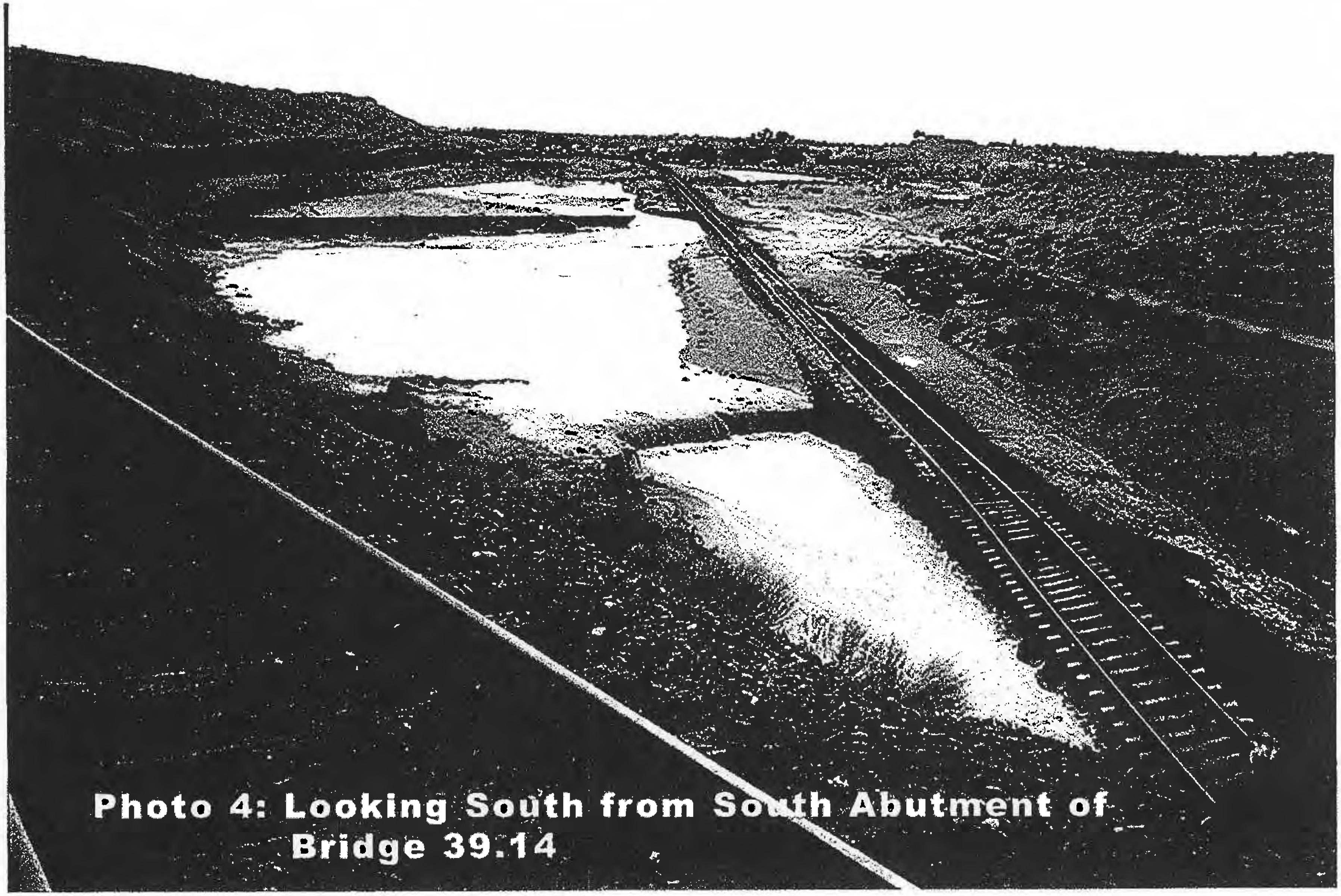
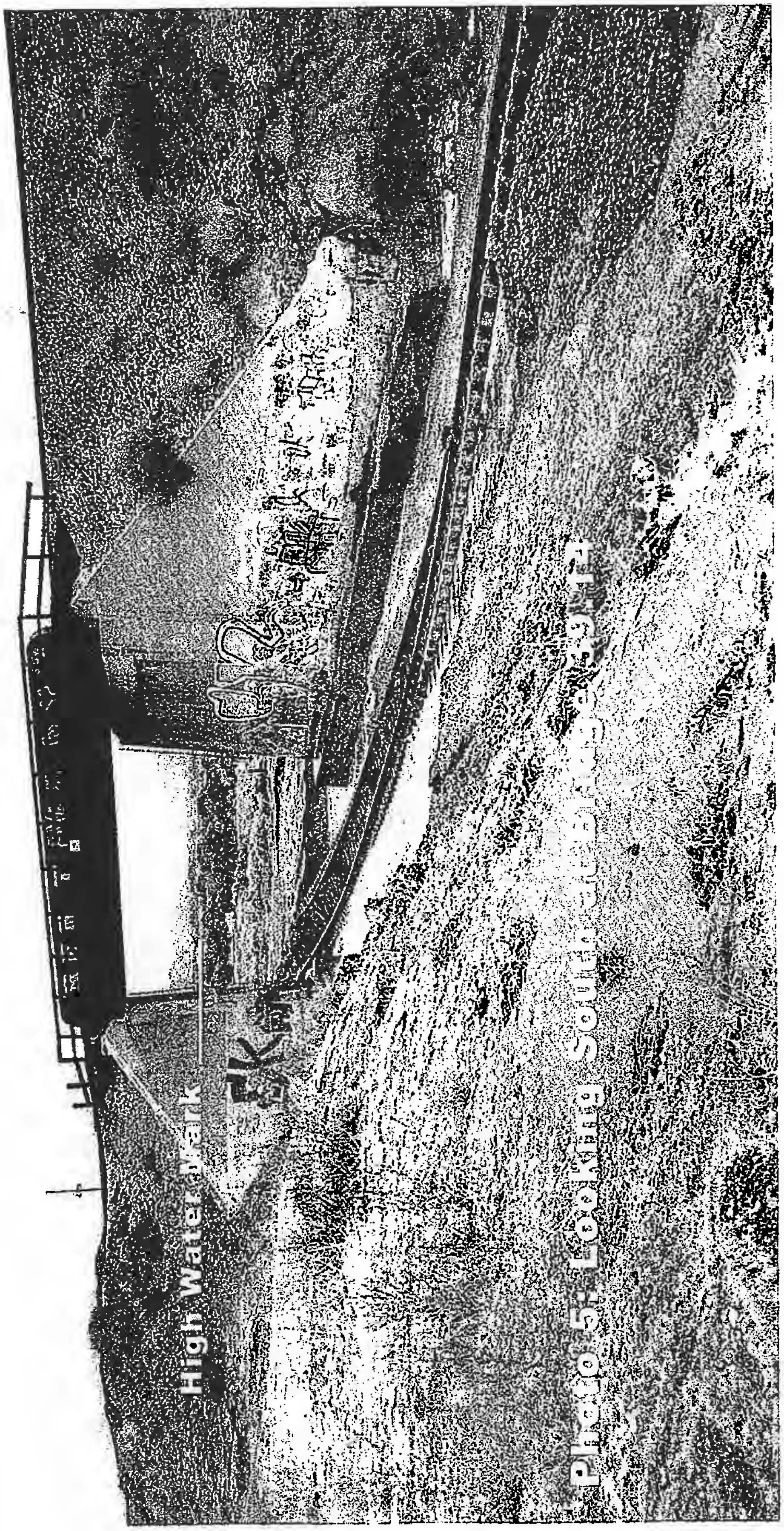


Photo 4: Looking South from South Abutment of Bridge 39.14


High Water Mark
Photo 5: Looking South

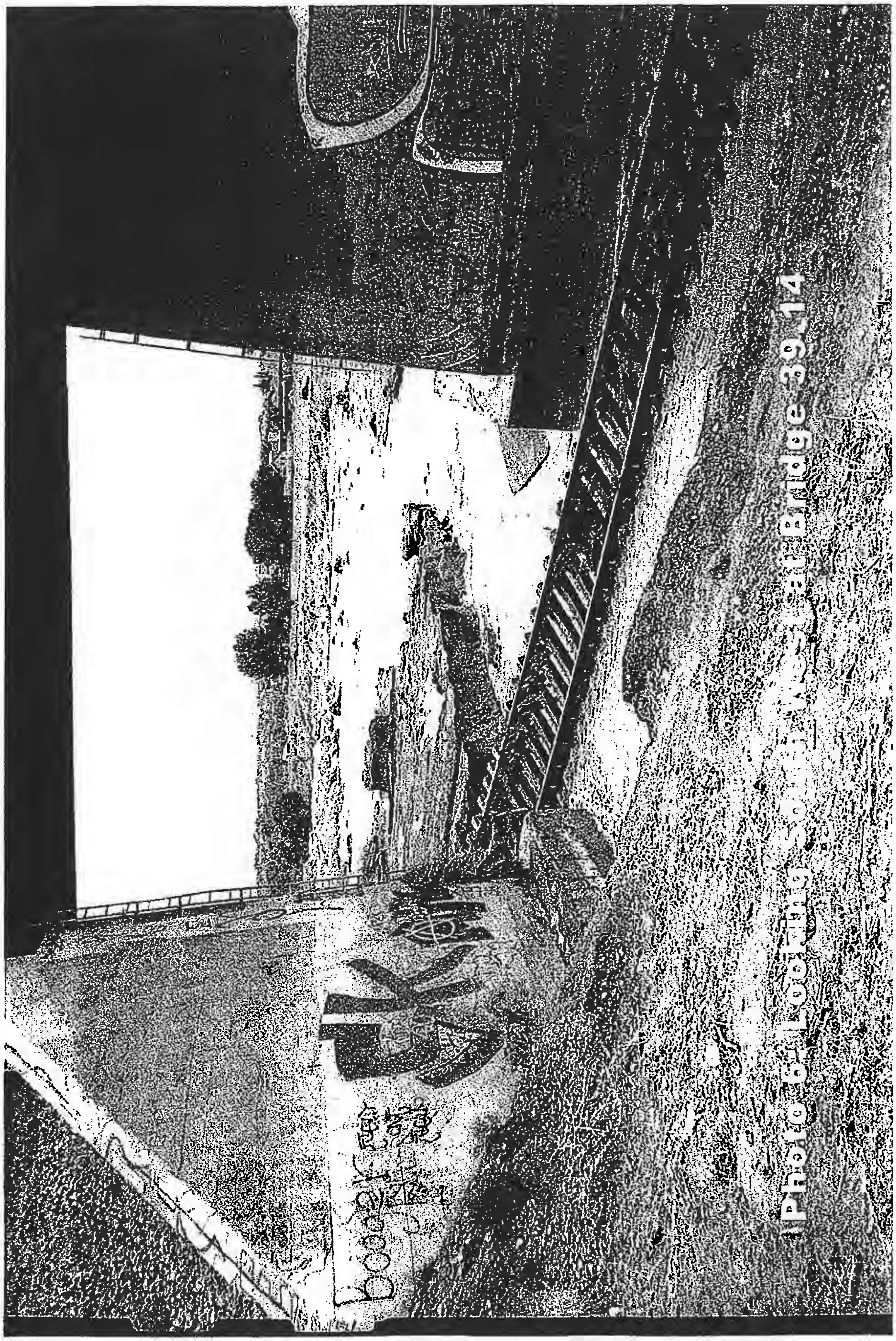


Photo 6: Looking South West at Bridge 39.14

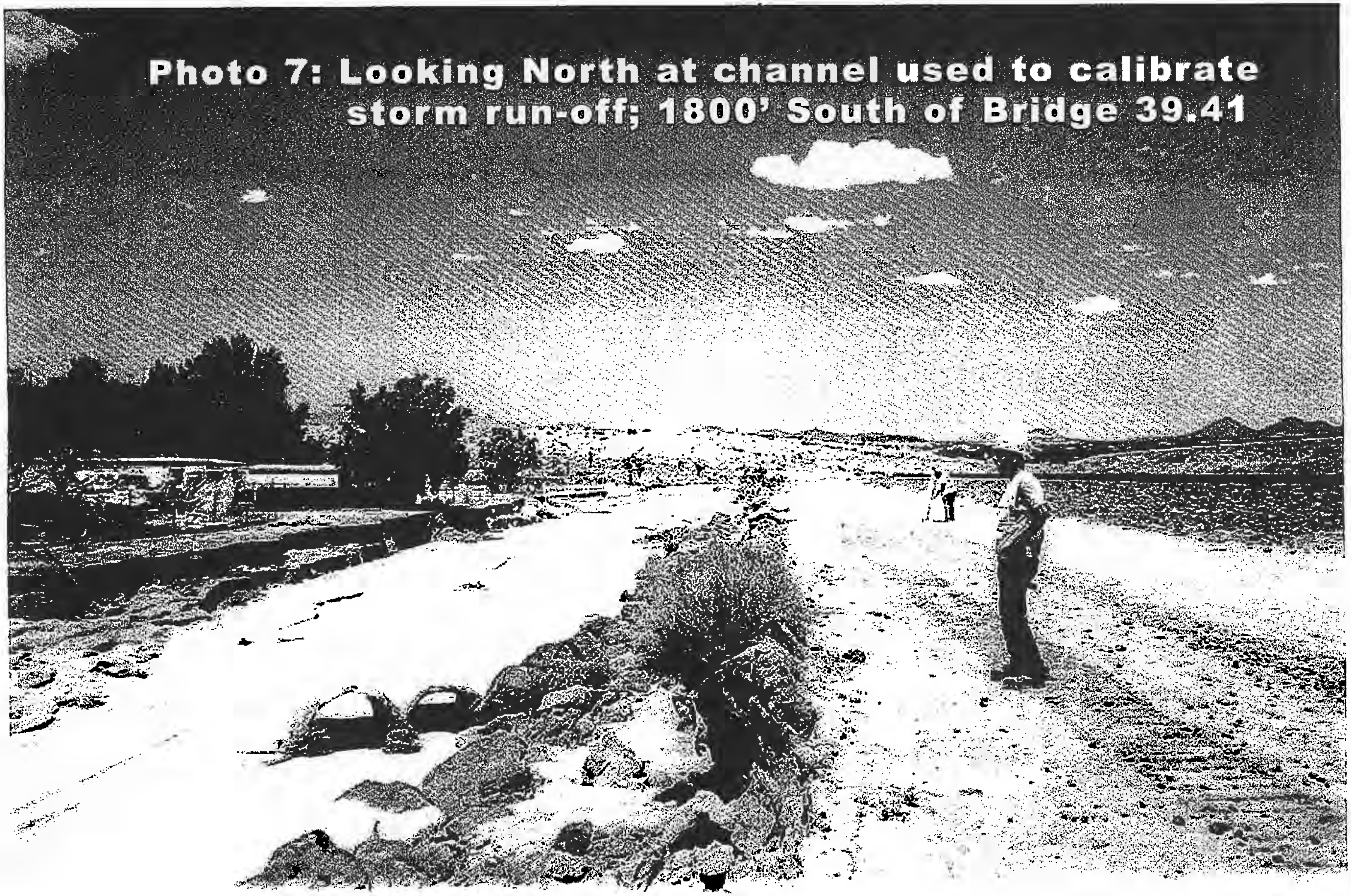


Photo 7: Looking North at channel used to calibrate storm run-off; 1800' South of Bridge 39.41

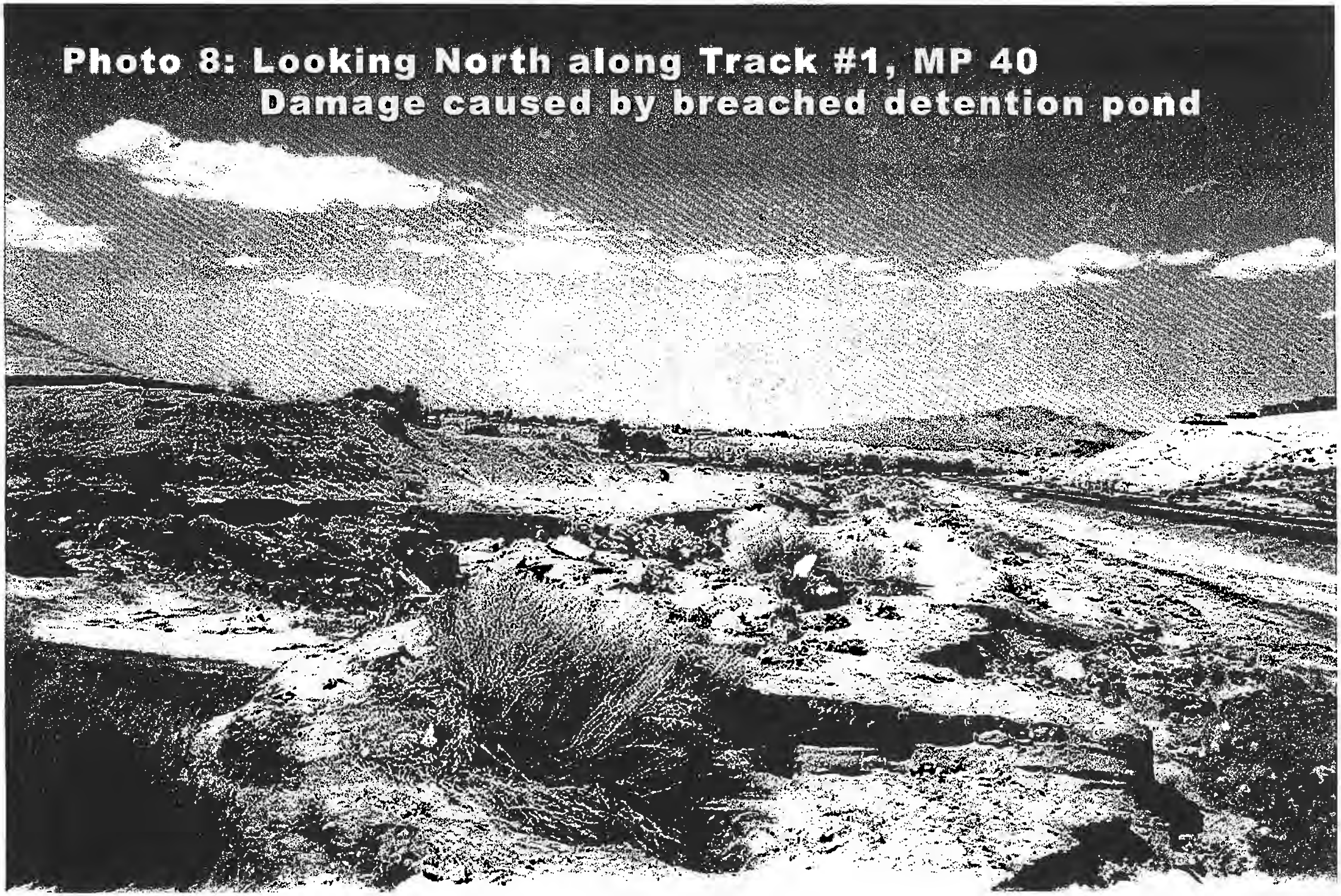


Photo 8: Looking North along Track #1, MP 40
Damage caused by breached detention pond

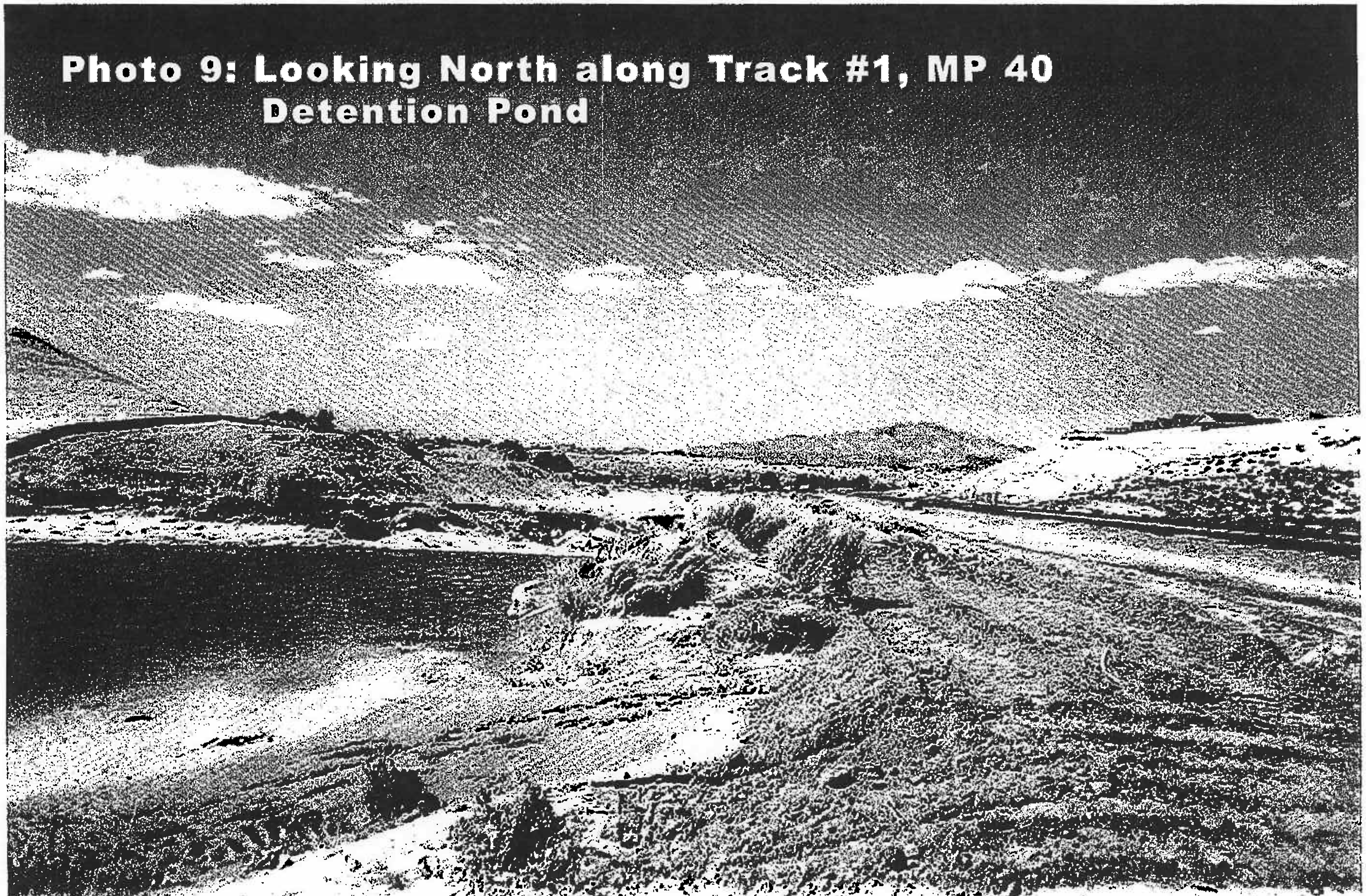


Photo 9: Looking North along Track #1, MP 40
Detention Pond

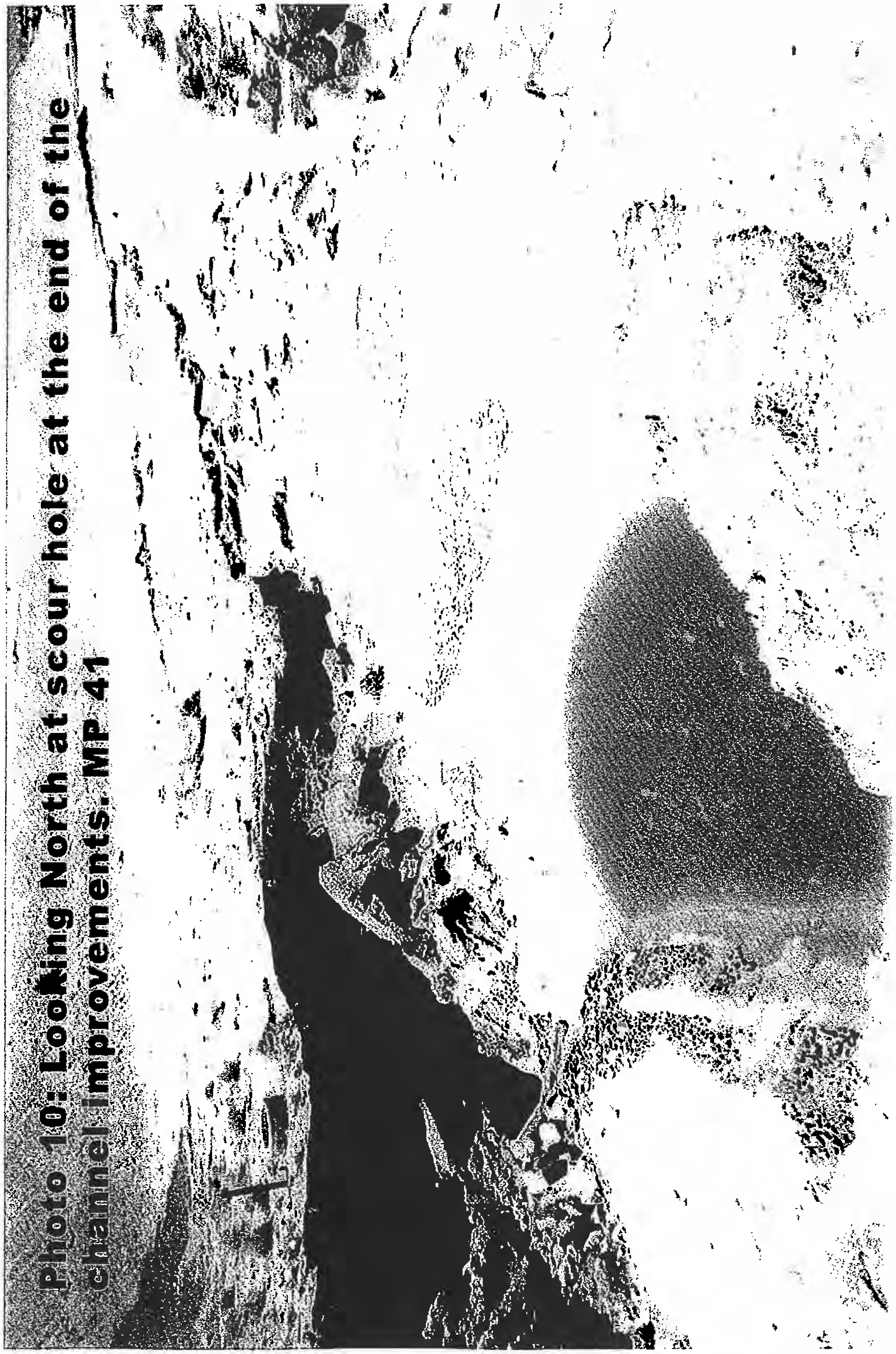


Photo 10: Looking North at scour hole at the end of the
channel improvements. MP 41

BNSF 003261

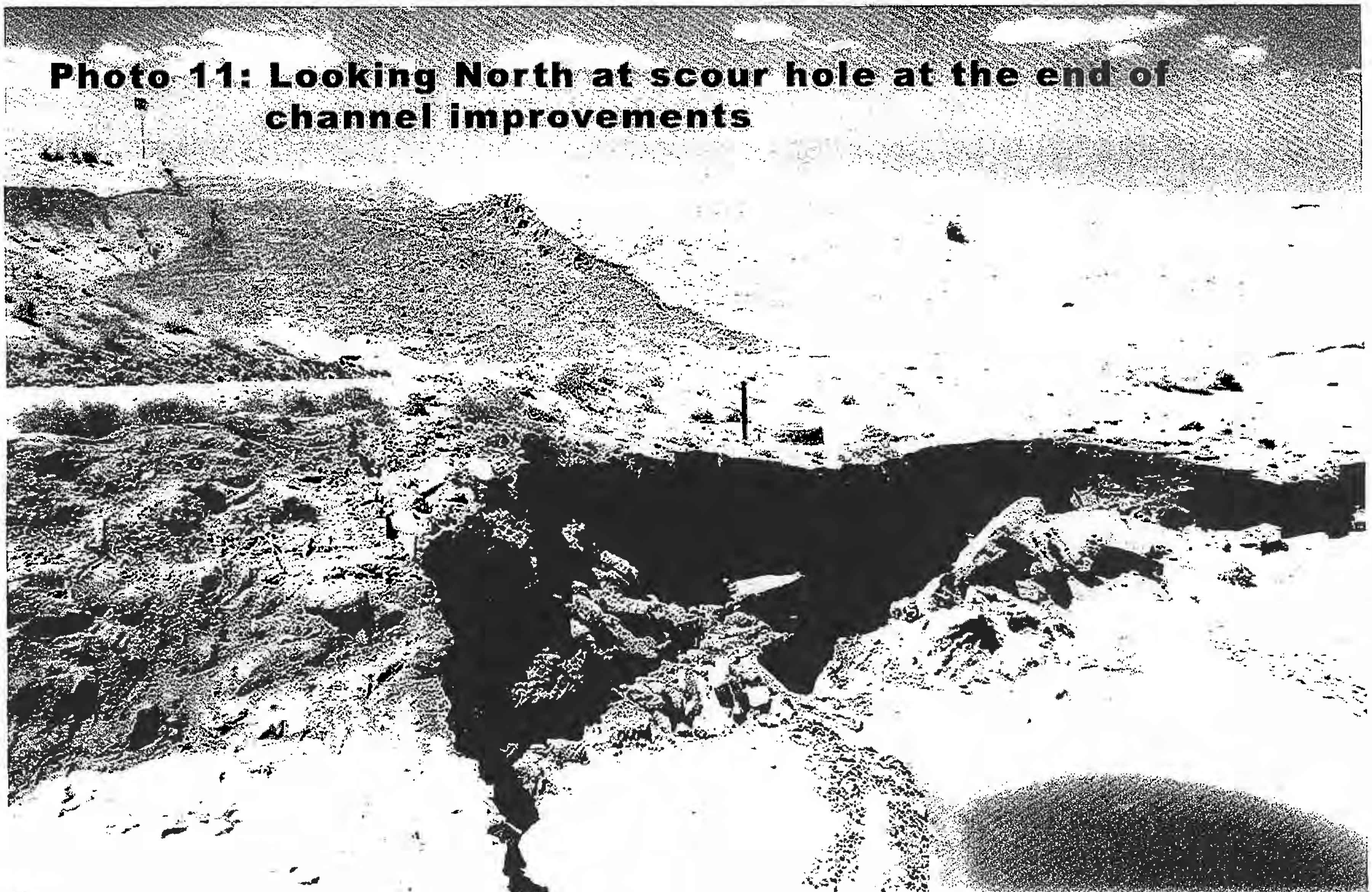


Photo 11: Looking North at scour hole at the end of channel improvements

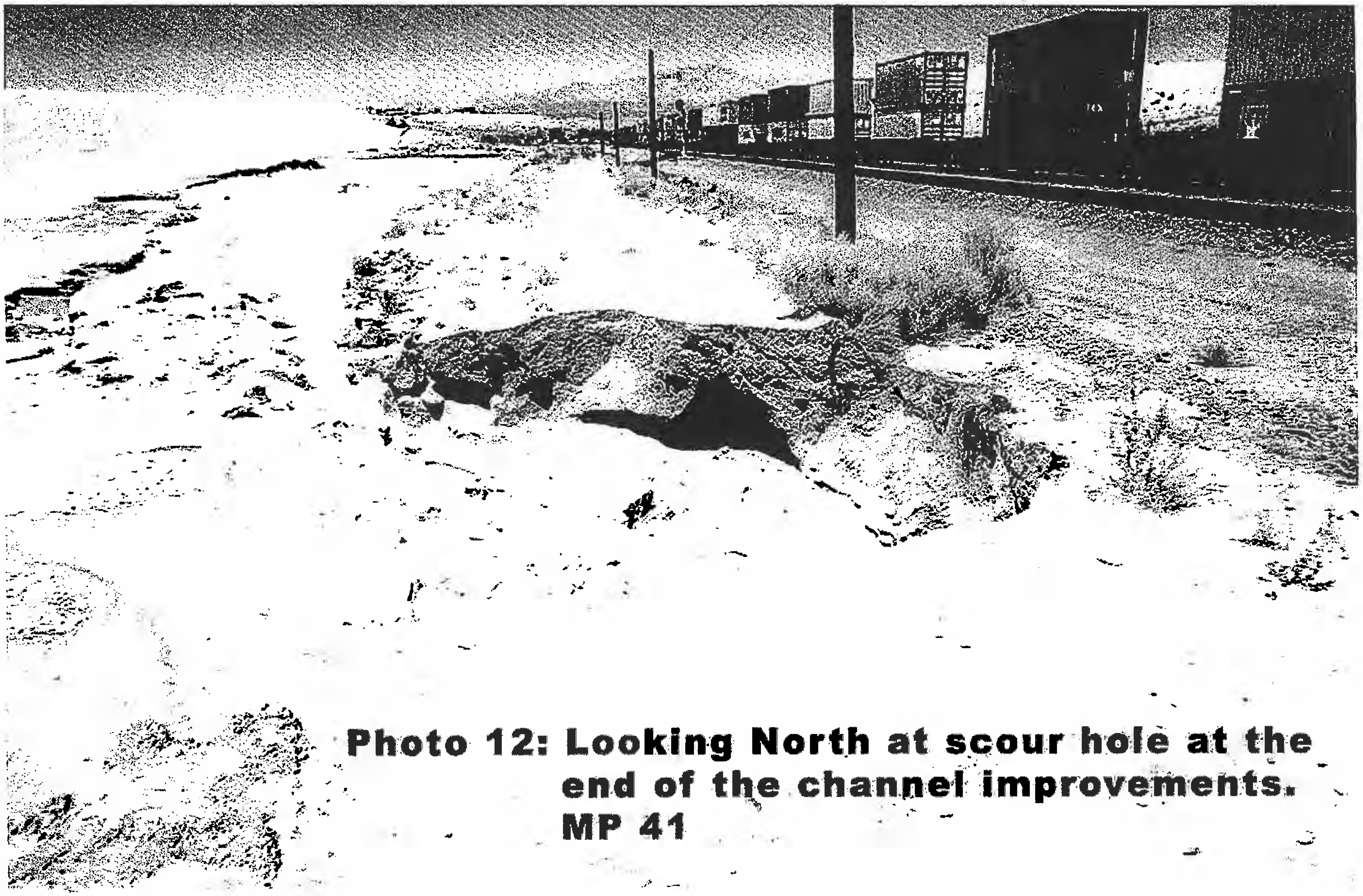


Photo 12: Looking North at scour hole at the end of the channel improvements. MP 41

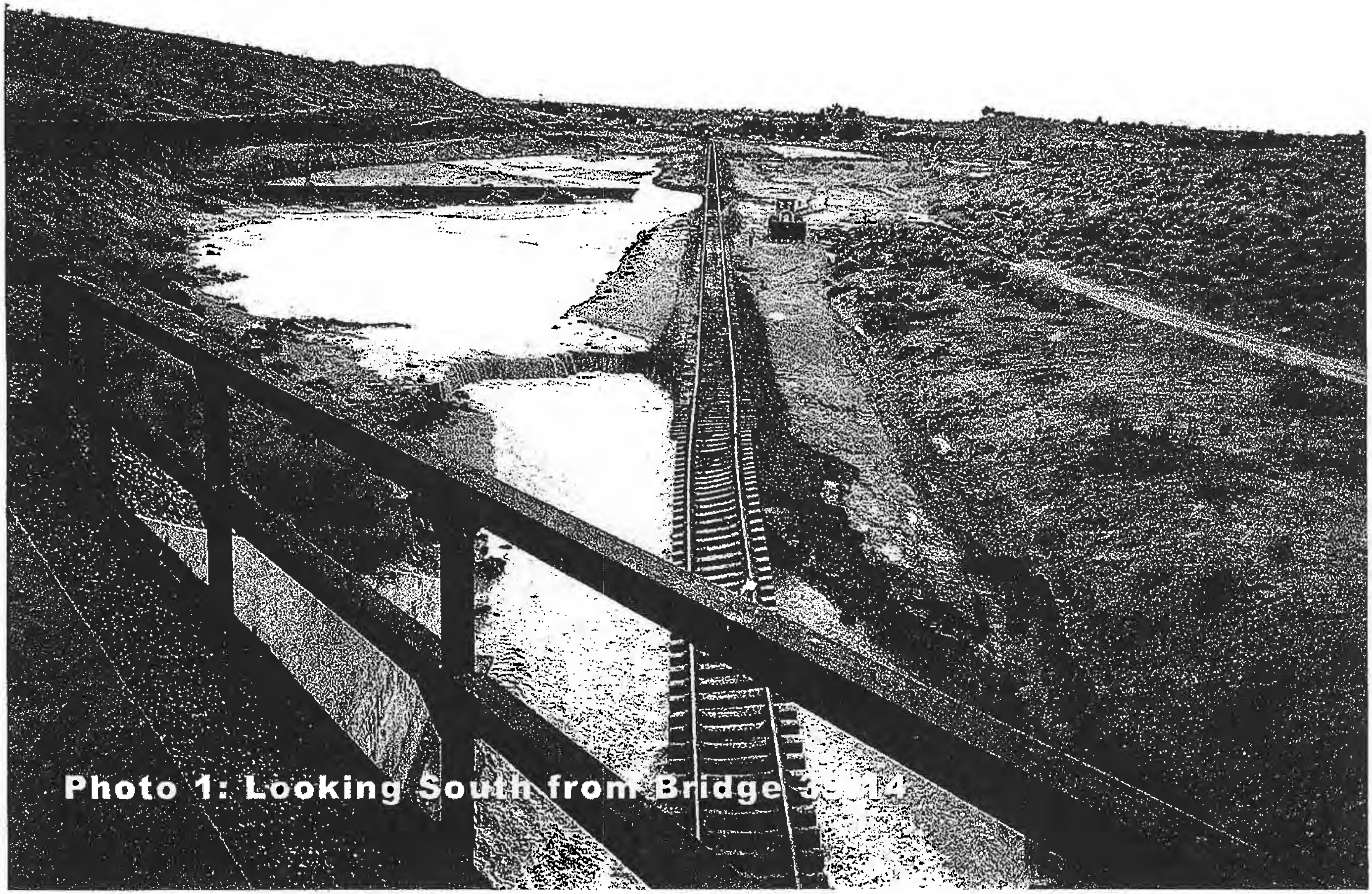


Photo 1: Looking South from Bridge [illegible]14

BNSF 003264

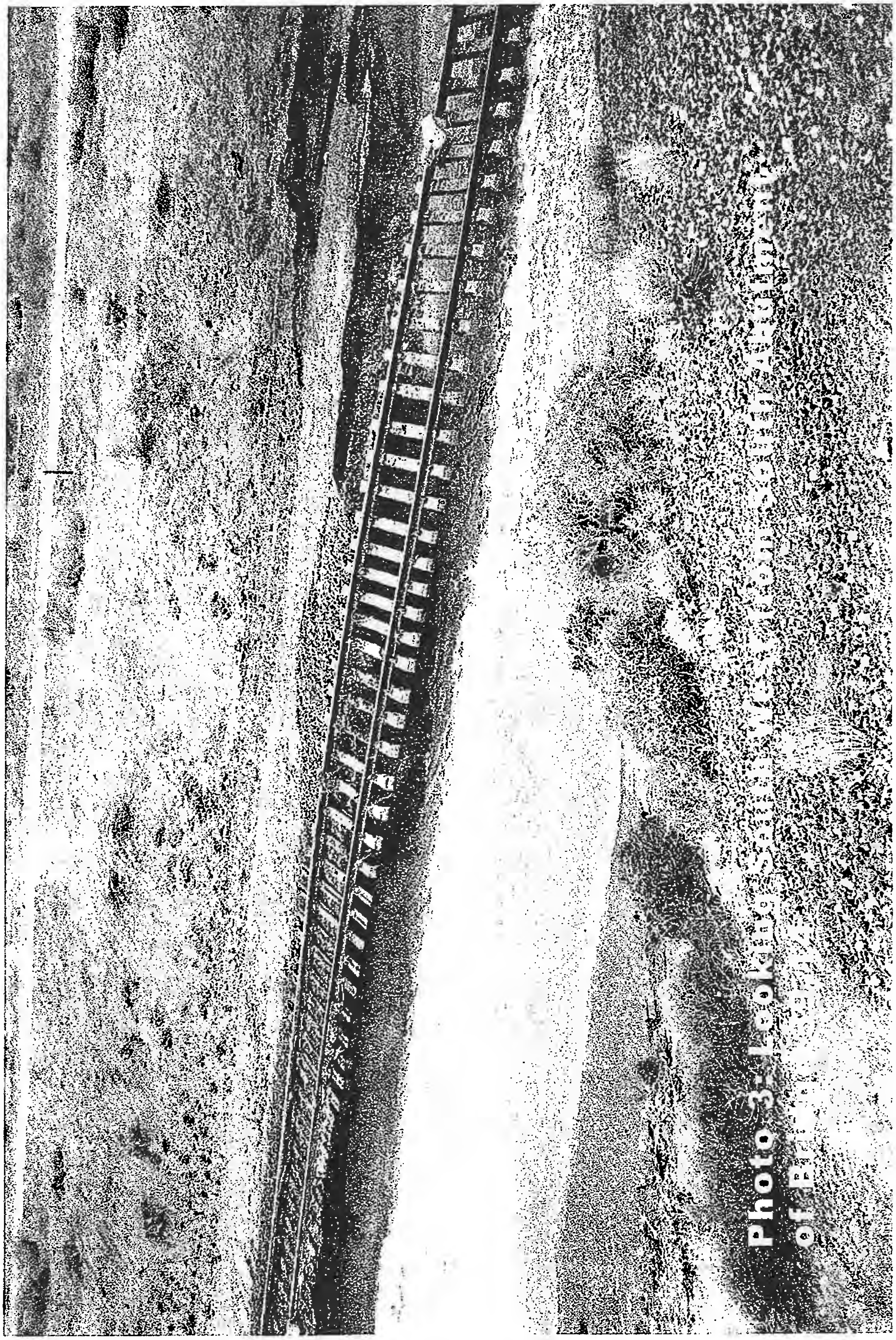


Photo 3 -

Exhibit H

STATE OF CALIFORNIA

Energy Resources Conservation And Development Commission

In the Matter of: The Application for Certification for the Calico Solar Power Project Licensing Case	Docket No. 08-AFC-13

PREPARED DIRECT TESTIMONY OF EDWARD P. PHILLIPS BNSF RAILWAY COMPANY

August 17, 2010

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BNSF Railway Company

Exhibit 1206

PREPARED DIRECT TESTIMONY

OF

Edward P. Phillips

Manager Environmental Operations – California Division, BNSF

Q.1 Please state your name and occupation?

A.1 My name is Edward P. Phillips. I am the Manager of Environmental Operations for the California Division of BNSF Railway Company ("BNSF"). I am based in San Bernardino, California. My resume was attached to my earlier testimony.

Q.2 What is the purpose of your testimony in this proceeding?

A.2 I will testify regarding access issues raised in the SSA, Part II, Traffic and Transportation.

Q.3 Why does BNSF have concerns regarding the Calico Solar Project?

A.3 BNSF is one of two Class 1 railroads operating in California. BNSF's transcontinental mainline, traversed by as many as 80 trains per day, carries interstate commerce from the Ports of Los Angeles and Long Beach to U.S. Midwestern, Southwestern and Eastern markets. BNSF's mainline has operated through the section of the Mojave Desert, where Calico Solar has now proposed its Project, since the late 19th Century. The proposed Project, comprised of 34,000 solar dishes (SunCatchers), transmission line upgrades, detention basins, etc., would surround both sides of approximately 5 miles of BNSF's mainline tracks. Accordingly, BNSF has significant concerns that the construction and operation of the Project do not adversely impact BNSF operations or otherwise impose unacceptable safety risks to BNSF personnel and operations. An adverse impact to rail traffic by Project construction or operations could have a devastating impact on interstate commerce and portions of this nation's economy. BNSF carries transcontinental shipments of, *inter alia* coal, grains and merchandise for everything from UPS to major retailers. BNSF trains currently run approximately every fifteen minutes in both directions and extend for over a mile in length. Because of the critical nature of the role of BNSF's mainline in interstate commerce, BNSF must maintain complete and unimpeded access to and use of its Right of Way ("RoW").

The consummation of the Project would require the granting of several licenses and permits from BNSF, which Applicant Calico Solar ("Calico Solar") has requested in a piecemeal fashion over the course of the past year. To date, only preliminary access agreements have been granted, including a permit to survey and a permit to use the RoW crossing at Hector Road. Before BNSF can grant such licenses and permits, BNSF must be assured that its significant safety and operational concerns are addressed.

Q.4 What are the access issues BNSF is concerned about in relation to the Calico Solar Project?

A.4 First, BNSF has been discussing various aspects of access with Calico Solar for some time. During all discussions, BNSF has made it clear that BNSF must maintain complete and unimpeded access to and use of its RoW and that any grant of access by BNSF to Calico Solar will be predicated first, on Calico Solar addressing BNSF's safety and operations concerns to BNSF's requirements and second, on Calico Solar obtaining all the appropriate and required permits and compliance with all applicable laws, ordinances, regulations and statutes. To date, significant concerns raised by BNSF have neither been studied nor addressed, e.g. the impact of glint/glare on railroad signals. Similarly, based upon information provided in the SSA Part II, Traffic and Transportation section, CEC Staff has proposed conditions, e.g. a paved roadway on BNSF's RoW, the impact of which has not been evaluated and it is unlikely that all required and appropriate permits in compliance with all applicable laws, ordinances, regulations and statutes can be achieved in the required time frames.

Second, as noted above, while there have been discussions between BNSF and Calico Solar related to Calico Solar having access to the BNSF RoW, only limited access has been granted to date. Significantly, the current access proposal set forth in SSA Part II at C.11-6 through C.11-18 and TRANS-1 is inconsistent with those discussions and, moreover, is inconsistent with Calico Solar's most recent proposal for access roads on the Project site as depicted in Figure No. 1-1, Phase 1a Project Features

Calico Solar, dated August 12, 2010 ("Figure No. 1-1"). BNSF Railway concluded and advised Calico Solar that the proposed construction activity would obstruct the use of its RoW for critical railroad operations and that they would not grant such a license. Since that time, BNSF and Calico Solar have been engaged in a discussion to determine the feasibility of the proposal reflected in Calico Solar's design dated August 12, 2010 ("Figure No. 1-1"). That design proposes a 2-3 month very limited use of the existing Maintenance of Way ("MoW") graded, dirt road on the northern side of BNSF's RoW, east of Hector Road, to permit Calico Solar to commence surveying, relocating tortoises and placing exclusionary fences. Concurrent with this use, Calico Solar would construct the permanent roadway along its property south of the RoW and BNSF would construct a temporary at-grade crossing to connect to the permanent road. The temporary at-grade crossing would be utilized until approximately October 1, 2011, when Calico Solar's proposed bridge-grade crossing over the BNSF RoW would be completed. The feasibility and terms of this approach are still being discussed between the parties. Once the bridge was built, Calico Solar would no longer utilize either of the at-grade crossings.

Third, building a permanent, two-lane asphalt road with culverts and gutters along either the north side of the RoW east of Hector Road or the south side of the RoW west of Hector Road, for a distance in excess of several miles, was never discussed. The proposed paved roads would cross several ephemeral streams, and permit the use of the road by over one to two hundred vehicles per day during the construction period. BNSF Railway believes that this proposed use may constitute a project under California's Environmental Quality Act (CEQA), and at a minimum, would require consultation with the U.S. Army Corps of Engineers to determine the jurisdictional nature of the ephemeral streams and potential Clean Water Act Section 404 Dredge and Fill permitting authority, similar consultation with the California Department of Fish and Game for potential state jurisdiction and Fish and Game Code Section 1602 Streambed Alteration Agreement authority, and either the California State Water Resources Control Board or Regional Water Quality Control Board for potential Clean Water Act Section 401 Certification. BNSF Railway also believes that the proposed road project would, due to its size, require a Construction General Permit to adequately cover the construction activities during the build-out of the road as required by California's Porter-Cologne Water Act. BNSF Railway believes that, as the land owner, such a permit would, by its regulatory requirement, encumber BNSF as a responsible party to this permit activity. BNSF has neither fully evaluated nor consented to these requirements. BNSF has discussed the possibility of using a class 2 base on the proposed road on the southern side of the RoW, west of Hector Road.

Fourth, as noted above, we never discussed a paved road within the RoW. We were always talking about minimal impacts to the RoW. Asphalt roads change the runoff coefficient of the land surface during rain events, change the natural drainage patterns of cross-directional run-on, and may impact BNSF Railway's track infrastructure significantly due to both the road runoff itself and the proposed drainage systems' focused flow patterns. BNSF Railway believes that this proposed road project warrants a hydrology study to determine the potential impacts to the railroad infrastructure. BNSF Railway believes that the proposed road project may also impact desert tortoise habitat and mobility in the immediate area. BNSF Railway believes that at a minimum, consultation with U.S. Fish and Wildlife and U.S. Bureau of Land Management is warranted on this potential impact.

These are the primary issues we were able to identify within the short time period of time that was provided to us.

Q.5 Does this complete your direct testimony?

A.5 Yes, it does.

I swear under penalty of perjury that this testimony is true and correct to the best of my knowledge and belief.

Dated: August 17, 2010

Edward P. Phillips

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION

***For the CALICO SOLAR** (Formerly SES Solar One)*

Docket No. 08-AFC-13

PROOF OF SERVICE
(Revised 8/9/10)

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DECLARATION OF SERVICE

I, Harriet Vletas, declare that on August 17, 2010, I served and filed copies of the attached Prepared Direct Testimony of Edward P. Phillips, BNSF Railway Company dated August 17, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:
[www.energy.ca.govlsitingcaseslsolarone].

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

_x__ sent electronically to all email addresses on the Proof of Service list;

___ by personal delivery;

___ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

_x__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

___ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 08-AFC-13
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

HARRIET VLETAS

*indicates change